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ABSTRACT

This document contains two papers commissioned by the Human Resources Commission of the National Research Council to explore the potential effects of military personnel requirements on the supply of scientists and engineers, and reaction to the papers from a one-day seminar of invited participants. The first paper, by Dr. Dael Wolfle, considers the implementation of policy alternatives such as an all-volunteer force, selective service, national youth service, and strengthening the reserves and national guard. It concludes that any of these options would not create a significant problem for the future supply of scientists and engineers under less than all-out emergency conditions. The second paper, by Dr. Richard Cooper, includes a detailed analysis based on knowledge of recent trends in military procurement, demographics, and various policy options open to the nation for meeting its military personnel needs. Cooper's paper (1) develops an analytical framework for addressing the effects of military personnel procurement policy on the future supply of scientists and engineers; (2) explores the possible effects under several alternate scenarios; and (3) establishes a research agenda for determining more precisely what these effects might be under a wide range of alternative circumstances. Participants in the conference indicated general agreement with the authors' findings and the way in which they were produced. The final conclusion of the conference was that military personnel requirements under less than major increases in force levels or mobilization conditions will not have a heavily negative effect on the output of scientists and engineers; and under some conditions, military personnel policies might increase this supply. (KC)

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The Effect of Military Personnel Requirements on the Future Supply of Scientists and Engineers in the United States

Papers and a Conference Report

Commission on Human Resources
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NOTICE

The project that is the subject of this report was approved by the Governing Board of the National Research Council, whose members are drawn from the Councils of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine. The authors and the participants in the Workshop responsible for the report were chosen for their special competences and with regard for appropriate balance.

This report has been reviewed by Commission representatives according to procedures approved by a Report Review Committee consisting of members of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine.

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FOREWORD

Late in December 1979, the Commission on Human Resources of the National Research Council authorized an exploratory study of the potential effects of military personnel requirements on the supply of scientists and engineers. The Commission was concerned that the national debate then in progress concerning the most effective way for the military to meet its personnel requirements did not involve sufficient attention to the long-range effects of military requirements on other national needs.

The Commission asked Dr. Dael Wolfle to prepare a paper on this topic based on probable national needs and alternative selective service policies in the next few years. Dr. Wolfle's paper, entitled "Potential Effects of Selective Service and of National Service on the Future Supply of Scientists and Engineers," was discussed by the Commission in June 1980. There was general agreement that the implementation of policy alternatives considered by Dr. Wolfle--an all-volunteer force, selective service, national youth service, and strengthening the reserves and national guard--would not create a significant problem for the future supply for scientists and engineers under less than all-out emergency conditions.

Dr. Wolfle's paper by design did not include an examination of the effect of any large-scale mobilization, a significant change in the degree of volunteerism, or major changes in the qualification levels. The Commission subsequently decided that these were important variables and, to complete its inquiry, asked a second consultant, Dr. Richard V. L. Cooper, to address them. Dr. Cooper's paper was completed in February 1981 and discussed by the Commission at its February 26-27 meeting. Entitled "Military Manpower Procurement Policy and the Supply of Scientists and Engineers," it included a detailed analysis based on knowledge of recent trends in military procurement, demographics, and various policy options open to the nation for meeting its military personnel needs, both enlisted personnel and officers. Specifically, the report was written with three purposes: (1) to develop an analytical framework for addressing the effects of military personnel procurement policy on the future supply of scientists and engineers, (2) to explore the possible effects under several alternative scenarios, and (3) to establish a research agenda for determining more precisely what these effects might be under a wide range of alternative circumstances. The paper met these needs quite satisfactorily, and the Commission felt reasonably secure about its understanding of this problem on the basis of this paper and the earlier one by Dr. Wolfle.

To subject these findings and the process that produced them to review by a group representing other organizations with an interest in this subject, the Commission convened a one-day conference on June 10, 1981. Eleven persons attended, including the authors, representing Brookings Institution, Congressional Budget Office, Congressional Research Service, Department of Defense, National Institutes of Health, National Science Foundation, Scientific Manpower Commission, higher

education, and the National Research Council. They had been given copies of the Wolfle and Cooper papers in advance and came prepared to discuss them. The discussion reported elsewhere in this document indicated general agreement with the findings and the way in which they were arrived at.

The conclusion of this study is that military personnel requirements under less than major increases in force levels or mobilization conditions will not have a heavily negative effect on the output of scientists and engineers. Indeed, under some combinations of policy alternatives, military personnel policies might increase this supply.

The present report makes available to a wider audience the papers by Wolfle and Cooper and some brief notes on the Conference on the Effect of Military Personnel Requirements on the Future Supply of Scientists and Engineers in the United States. It is a pleasure to express the Commission's thanks to Dael Wolfle and Richard Cooper, to the participants in the Conference, and to staff members Linda Dix and Kathleen Drennan for their assistance in carrying out this study.

Harrison Shull
Chairman
Commission on Human Resources

October 1981

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POTENTIAL EFFECTS OF SELECTIVE SERVICE AND OF NATIONAL SERVICE ON THE FUTURE SUPPLY OF SCIENTISTS AND ENGINEERS*

Dael Wolfle
University of Washington

JULY 1981
(REVISED)

*This paper was submitted in March 1980, before Congress had acted on President Carter's request for authority to reactivate registration for men and to require women also to register. The paper was revised in July 1981 to reflect the facts that Congress authorized the registration of men but not women and that the Supreme Court later upheld this decision as constitutional. The argument and calculations remain substantially as they were in the original version.

I. INTRODUCTION

Authority to draft men for military service in the United States expired in 1973. Since then the nation has relied on an All-Volunteer Force (AVF), to the satisfaction of some observers and the dismay of others. Supporters of the All-Volunteer Force point out that enlistments and reenlistments have kept the total force very close to planned strength and add that the percentage of volunteers with high school diplomas increased from 61 percent in 1974 to 70 percent in later years (although it has recently declined). Critics reply that the number of men and women enlisting for more than one or two periods is inadequate, that there are shortages of personnel with some of the needed technical skills, that too few veterans enlist in the Reserve Forces, and that the All-Volunteer Force is too costly.[1]

Supporters and critics agree, however, on two points. They agree that special efforts will be necessary to keep the military forces at

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[1] There are three major points of contention concerning the All-Volunteer Force and the speed with which the country could respond to the need for mobilization. The All-Volunteer Force is criticized as consisting too heavily of blacks and members of other minority groups, which now constitute about 40 percent of combat forces and over a fourth of the total active-duty forces. The All-Volunteer Force is criticized as being too expensive; it is said to have cost over $18 billion more in the last six years than an equivalent Selective Service force would have cost. Also there are serious doubts that mobilization could proceed rapidly enough. In the event of mobilization, the active-duty forces would constitute the first line of defense, backed up by the various categories of reserve forces and then reinforced by draftees. Active-duty forces are not considered combat-ready. Further, the Selective Service System would, it is charged, not be able to meet the Department of Defense schedule of receiving the first inductees within 30 days of Mobilization Day; 100,000 draftees within 60 days, and 650,000 within 180 days of mobilization. White House advisors have estimated that the now reinstated peacetime registration would save 90-100 days in mobilization; the Selective Service System contends that only 7 days would be saved.

The Department of Defense mobilization schedule, deficiencies of the standby Selective Service System, and several estimates of the time that would be required for mobilization are discussed in The Selective Service System: Mobilization Capabilities and Options for Improvement, Congressional Budget Office, Congress of the United States, November, 1978.

A quick summary of the arguments against the draft are given by Murray Polner, "Opening Pandora's Box," and against the All-Volunteer Force by Harry A. Marmion, "It Just Isn't Working," both in Commonwealth, October 12, 1979, pages 553-557.

An example of Congressional debate and conflicting attitudes can be found in the Congressional Record, Vol. 125, 96th Congress, 1st Session, September 12, 1979, pages H7714-7783.

planned strength as the young age-groups that supply most volunteers become smaller and smaller in the years ahead. They also agree that a draft would have to be reactivated immediately if full-scale mobilization became necessary.

It is not the purpose of this paper to examine the merits or deficiencies of the All-Volunteer Force, of a Selective Service draft, or of a possible National Service Program. Rather, the purpose is to analyze one particular effect of a Selective Service draft or a National Service program, namely the effect on the future flow of scientists and engineers into the nation's workforce. There are four possibilities to consider:

1. The present system that requires registration by all young men upon reaching age 18 and includes no draft but relies upon volunteering to maintain the armed forces at their authorized strength.

2. Resumption of a Selective Service draft to make up for a shortfall of volunteers for military service.

3. Adoption of a national program of civilian service (This is a development hoped for by several analysts of some of the difficulties encountered by many young men and women -- and by society at large -- in today's world.)

4. Adoption of the McCloskey Bill or similar legislation that would combine civilian service with inducements for volunteering for military service and would provide for a draft for military service.

The Demographic Trend

One overriding factor in trying to project the employment of young scientists and engineers in the next two decades is the fact that the 18- to 21-year-old age-group will decrease steadily until 1994, when there will be only three-quarters as many 18- to 20-year-olds as in the peak year of 1979. After 1994, this age group will again become larger, but it will be well into the next century before it matches the 1979 peak.

As the age-groups get smaller, occupational opportunities will brighten for some of the young people coming into the labor market or attending college to prepare for their careers. But this may not be true for all. As the age-groups get smaller, the ethnic and racial minority percentage will gradually rise. Partly for this reason, the Congressional Budget Office predicts that the decline in the size of the age cohorts will bring only marginal lowering of unemployment rates for disadvantaged young people. Thus, the attractiveness of voluntary military service and the reasons for advocating some forms of national service may remain about as great for the smaller cohorts of the future as they have been in recent years, while the need for Selective Service and concerns over the adequacy of the supply of scientists and engineers may both increase.

Assumptions

The estimates to be presented shortly of the effects of Selective Service and of national service on the future supply of scientists and engineers are based on the following assumptions:

1. The size of the armed forces (around two million) and the physical and mental requirements for entry will remain approximately as they are now.

2. If a Selective Service draft is conducted in peacetime, only men will be drafted. In contrast, if a national service program is started, both men and women will participate.

3. There will continue to be a program of financial assistance to aid veterans of military service to attend college or to secure other forms of training.

4. The proportion of 18-year-olds who later enter scientific or technical occupations will remain near the present level, with the selection ratios from age 18 to entrance into those occupations as shown in Table 1. Note that the ratios shown in this table are used throughout to estimate numbers of college students, college graduates, and future scientists and engineers who would be involved in any of the service programs considered.

II. REGISTRATION WITHOUT A DRAFT

Current regulations require each young man to register upon reaching age 18. By itself, this requirement should have no influence on the future supply of scientists and engineers. So far, over 90 percent of those eligible have complied with the registration requirement. Some of the others were probably waiting to see if the Supreme Court upheld the men-only requirement. Some, however, may object to registration so strongly that they will leave the country rather than register. In last year's Canadian elections, the leaders of both parties announced that Canada would not be a haven for young men seeking to escape a U.S. draft, as it was during the Vietnam War. However, flight to other countries would still be possible, and a few students might leave the country rather than register. A fraction of them might be future scientists and a smaller fraction future engineers. But it seems unlikely that their number would be large enough to have any measurable effect on the future stock of scientists and engineers.

III. RESUMPTION OF A SELECTIVE SERVICE DRAFT

In 1979, when Congress was considering the Fiscal Year 1980 Authorization Bill for the Department of Defense, a number of members questioned the effectiveness of the All-Volunteer Force and the readiness of the Reserve Forces, and many doubted the ability of the standby Selective Service System to respond rapidly enough in case mobilization became necessary. Accordingly, the Appropriation Bill included

a request to the President to make a study of the advisability and feasibility of resuming mandatory registration, the desirability of requiring women as well as men to register, the possible advantages of

TABLE 1: Educational selection of future scientists and engineers; Percentage of 18-year-old men and women reaching each state [2]

	TOTAL	Men	Women
Reach age 18	100%	100%	100%
Finish high school	73%	71%	75%
Enter college in degree credit status	42%	45%	40%
Graduate from college	22%	23%	21%
Earn a degree in scientific or technical field[3]	10%	11%	8%
Enter scientific or technical occupation[3]	4.5%	6%	3%

[2] Figures in the first five lines are from recent national experience and projections reported in Projections of Education Statistics to 1988-89, Washington, D.C.: National Center for Education Statistics, 1981, by Martin M. Frankel and Debra A. Gerald. The figures in the final line are estimates of the numbers of college graduates who enter scientific and technical occupations directly after graduation or after additional graduate or professional education. These estimates are based upon Review of Data on Science Resources, Washington, D.C.: National Science Foundation, No. 32, June 1978, and No. 36, May 1980. This table should not be used to estimate anything other than first entry into scientific and technical occupations. National Science Foundation reports on employed scientists and engineers show a smaller percentage of men and an even smaller percentage of women college graduates employed in those fields than would be inferred from the final line of the table. There are two reasons: this table includes health workers who are not included in the NSF category of scientists and engineers; and substantial numbers of both men and women who enter scientific or technical occupations later transfer to other occupations or withdraw from the labor force. Thus, the table is intended to indicate first entrants in the next few years, not the entire labor force or the entire lifetime working experience of new college graduates. I am indebted to Martin M. Frankel of the National Center for Education Statistics and James Brown of the Division of Science Resource Studies of the National Science Foundation for making some of the information available prior to publication.

[3] Includes mathematics; physical, biological and social studies; engineering; agriculture; and health fields.

also adopting some form of national service, and the desirability of other changes that might strengthen the ability of the nation to respond rapidly if the need for mobilization should arise.

President Carter's response to this request[4] asked Congress to appropriate funds to resume registration of young men and to grant authority and funds to register -- but only for non-combat service -- young women. He specifically did not propose to resume examination, classification, or drafting of any of the registrants. On the contrary, he explained, "My decision to renew registration is in no sense a move away from the volunteer force, which is performing its mission well. We are maintaining our armed forces with volunteers, and recruitment is holding up well."[5]

Congress refused to approve the registration of women but did enact legislation requiring all men born in 1960 or 1961 to register during 1980 and thereafter, beginning on 1 January 1981, for each young man to register upon reaching the age of 18.

Despite President Carter's statement early in 1980, mandatory registration could lead to a more active Selective Service System. The nation has a new President and a new Administration dedicated to strengthening the nation's defense capabilities. A considerable number of members of Congress question the effectiveness of the All-Volunteer Force. Public opinion is divided, but there would be substantial public support for a draft, as indicated by the two Gallup polls summarized in Table 2.[6]

TABLE 2: Public attitudes toward registration and a draft

	February 1980		March 1979	
	Yes	No	Yes	No
Favor registration?	83%	13%	70%	17%
Register women?	56	40	50	41
Return to draft?	59	36	45	46
Draft women?	51	45	43	50
Women in combat role?	41	54	44	51

4 Presidential Recommendations for Selective Service Reform, a report to Congress prepared pursuant to PL 96-107, February 11, 1980.

5 Statement by the President, Office of White House Press Secretary, February 8, 1980.

6 George Gallup, "Public Favors Draft for Men and Women," The Seattle Times, March 2, 1980, A22.

Current international tensions and public attitudes make it easy to imagine that a peacetime draft could be authorized. Selective Service would then be used to induct as many men as necessary to supplement the number who volunteer. What this development would mean for the future supply of scientists and engineers cannot be predicted precisely, but some reasonable estimates are possible. From 1974 through 1980, the number of new voluntary enlistments needed to maintain planned strength averaged about 400,000 a year. How much of a shortfall would be required to force resumption of Selective Service is debatable. So far, the largest shortfall has been seven percent, in 1979. That was not sufficient to lead to a decision to abandon the All-Volunteer concept, but a shortfall of, say, 25 percent probably would be.

A shortfall of 25 percent would equal 100,000 too few volunteers a year. Enlistment periods vary among the military services but assuming -- to simplify the calculations and discussion -- that all volunteers would serve for the Army enlistment period of three years and all inductees would serve for two years, a shortfall of 100,000 volunteers would require a drafting of 150,000. This is probably a high estimate. From 1961 through 1964, when the number of men reaching age 18 each year was only about 70 percent of the current number, induction through Selective Service ranged from 60,000 to 150,000 a year; and during the 1966-70 peak of the Vietnam War, inductions ranged from 200,000 to 350,000 a year. Under current conditions, if pay and other benefits remain as they are or are improved as is frequently being recommended, a shortfall of 100,000 volunteers does not seem likely. Thus, an estimate that Selective Service might be required to induct as many as 150,000 men a year seems a safely high basis for calculating the effect upon the flow of future scientists and engineers into the labor force.

Resumption of a draft would motivate some college men to volunteer in order to be able to serve in the military service of their choice, to obtain the type of duty they preferred, or to serve at the time that best fitted their educational and other plans. In all of the calculations that follow, these draft-motivated volunteers have been grouped with those actually drafted. No separate estimates of the number of draft-motivated volunteers and the number of draftees are offered, for it seems reasonable to assume that although the draft-motivated volunteer would serve three or four years instead of the draftees' two years, the future scientists and engineers in the two groups would act in about the same way in completing their education and in making other career decisions.

For the next few years, each of the 18-, 19-, and 20-year-old age-groups will include about 2.0 to 2.2 million men. The average is about 2.1 million, of whom about 900,000 will enter college in a program leading to an academic degree. Note that throughout this paper, the "college group" is defined as students in degree-credit programs. Thus, some members of the "non-college" group may have some college experience, usually in two-year institutions, for work not credited toward a degree.

The 1.2 million men in the non-college group include the assumed 300,000 who volunteer for military duty. Actually, about eight percent of the volunteers are women, and a few volunteers come from the college group; but to simplify calculations, assume that all 300,000 volunteers are non-college men. Historically, about 35 percent of young men have been unqualified for military service for mental or physical reasons. The college group, however, should all be mentally qualified; therefore, assume only 20 percent are unable to meet physical requirements. The assumptions lead to the estimate that the draft pool from each age group would consist of the following:

720,000 college men (the 900,000 in or about to enter college, less 20 percent not physically qualified for military service); and

585,000 non-college men (the 1.2 million total, less 300,000 volunteers, less 35 percent not qualified for military service).

Under random selection, 55 percent of the annual draft of 150,000 -- or 83,000 men -- would be drafted from the college group (including college dropouts) and 45 percent -- or 67,000 men -- from the non-college group.

Among these 83,000 college men, the number of future scientists and engineers can be estimated by the following series of reductions (see Table 1):

1. Of all men who enter college in degree-credit programs, approximately 52 percent earn baccalaureate degrees; 52 percent of 83,000 is 43,000.

2. Of men who graduate from college, some 46 percent have majored in mathematics, a physical or biological science, a social science, engineering, agriculture, or a health field; 46 percent of 43,000 is 20,000.

3. Of the men who earn bachelor's degrees in these fields, approximately 56 percent enter scientific, engineering, or other technical occupations. The percentage varies widely from close to 90 percent in engineering down to around 20 percent in the social sciences. The 56 percent figure is the average for the entire group; 56 percent of 20,000 is 11, 000.

Thus, the 83,000 college draftees would include about 11,000 potential members of scientific and technical professions. Some would be lost to those professions as a result of having been drafted, but there would probably also be some new recruits, men who had not planned on such careers but whose plans were changed by their military experience. How the gains and losses would balance is a matter of guesswork. However, seemingly reasonable is the assumption that nearly all of those with the ability and motivation which, under other circumstances, would have kept them on track to scientific or technical careers would not be deterred by being drafted but would

take advantage of the educational benefits they had earned and would return to college. Therefore, for most of the men involved, the primary effect of a draft would be the interruption of college education or the postponement of entry rather than the abandonment of their earlier plans. After a temporary dip in the number of college graduates, a normal flow would be restored as the return of veterans to complete their education would offset the withdrawal of new inductees.

Currently, about 420,000 students -- both men and women -- earn bachelor's degrees in one of the scientific and technical fields. About 200,000 of these students become employed in one of those fields. If the expected 56 percent of the men and about 36 percent of the women who earn degrees in these fields actually enter scientific or technical occupations, the 11,000 men who were drafted would constitute about 5.5 percent of the total number of men and women annually entering scientific and technical professions in the years immediately ahead; about six percent in the last years of this decade; and perhaps seven percent, or a bit more, in 1994 when the young age-group involved are at their minimum size.

Were a draft to be instituted, the actual record would surely differ from these illustrative figures. However, the number of future scientists and engineers would be directly related to the total number of men who needed to be drafted; if draft requirements turned out to be greater -- or less -- than the 150,000 a year, the number of future scientists and engineers drafted would be proportionately larger -- or smaller. To the extent that women enlist, or are drafted if the rules are changed to call for the induction of women as well as men, the impact of the draft on future scientists and engineers would be diminished. If women were drafted along with men, the total number of draftees from the college group would be smaller than if only men are drafted, for the group of non-college women is not reduced by a large number of volunteers as is the group of non-college men; currently, about eight percent of volunteers are women. Consequently, a larger proportion of drafted women than of drafted men would come from the non-college group. Moreover, although the disparity is diminishing, men are still more likely than women to enter scientific and technical fields. Therefore, drafting of college women would have a smaller impact on the future flow of college graduates into scientific and technical occupations than would drafting of men.

Note that in all of these calculations nothing has been said about deferment. Deferments for educational and occupational reasons were eliminated in 1971, and there is little likelihood of their early reinstatement under peacetime conditions. The policy of deferring students who met stated quality standards that were adopted during the Korean War were justified on grounds of national interest: some students were considered to be of greater value to the military services and to the nation as a whole after they had completed their educational programs than before.[7] In the 1960s, the deferment policy was

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[7] M.H. Trytten, Student Deferment in Selective Service, Minneapolis, Minnesota: University of Minnesota Press, 1952.

broadened to include all college students making satisfactory progress. Shortly thereafter, the military decision to draft youngest first instead of oldest first turned some of the student deferments into permanent exemptions, and the deferment policy got a bad name.[8] Now, representativeness of the whole population is the value being emphasized. In the Vietnam War, 43 percent of those killed were members of racial or ethnic minorities. Minority groups now provide approximately that proportion of combat forces. While that percentage may be acceptable in a volunteer force, there is little official sentiment to let "rich college kids" escape the draft that falls on their less fortunate age-mates. The future need for scientists and engineers will have little weight either in deciding whether or not a draft is needed, or in determining the rules under which one is conducted. Consequently, the above estimates have been based on the assumption that there will be no educational deferments. Students who are called during the academic year can, however, have induction postponed until the end of the term, and any seniors called for induction can request a postponement until the end of the academic year.

The general conclusions are that (1) if Selective Service is resumed to maintain a peacetime armed force, prospective scientists and engineers will be drafted in proportion to their numbers; (2) the draft will delay the educational progress of approximately five to six percent of the members of each age group who would become scientists and engineers; but (3) after two years of military service, they will have educational benefits to help them attain the education needed to achieve their objectives.

IV. NATIONAL CIVILIAN SERVICE

A program of national service would provide young people with opportunities to devote a year or more to some form of socially useful service; cleaning up and improving the environment, reforestation, energy saving programs, day care centers, enhanced service to the sick and elderly, tutoring children who are lagging behind schoolmates, and other work that would benefit the community. The national service idea has been discussed for 40 years or more, at least since World War II terminated President Roosevelt's plans to combine the Civilian Conservation Corps (CCC) with the National Youth Administration (NYA). National service was the high school debate topic in 1968-69 and has been the topic of several studies, conferences, and Congressional bills in recent years. President Carter's report on Selective Service rejected the idea of national service because the authors thought it would not increase volunteering for military service.[9] The idea still has some support in Congress and much support among young people. In February 1979, a CBS/Associated Press survey found an even split of 46 percent of 18- to 24-year-olds favoring and 46 percent op-

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8 Harry A. Marmion, Selective Service: Conflict and Compromise, New York: John Wiley and Sons, 1968.

9 Presidential Recommendations for Selective Service Reform, op. cit.

posing universal service. The other eight percent were uncertain. An August 1979 Gallup poll found 71 percent of teenagers favoring and 20 percent opposing national service.[10]

There are several arguments for such a program, only one of which is that it might encourage voluntary enlistments in the armed forces. The first is that there is much socially useful work that needs doing but that is unlikely to be provided through the operation of the market place. Another is that many young people would welcome the opportunity to spend a year or so in work they consider socially beneficial, and they would personally benefit from the experience and training they would receive. Finally, the argument is sometimes made that the rights of citizenship are accompanied by an obligation to render service to the community.

A few small-scale examples of national service already exist. The VISTA program, which has never involved more than 5,000 participants a year, is one. Also, the smaller program known as "University Year for ACTION" provides a year of full-time service to a limited number of college and university students while the student also receives a year of academic credit for the learning outcomes of the service rendered, with those outcomes being monitored and evaluated by a member of the university faculty. Other programs that provide opportunities for youth service include the Peace Corps, the Teachers Corps, the Young Adult Conservation Corps, and the National Health Service Corps. From farther back in time, there are the precedents of the Civilian Conservation Corps and the National Youth Administration, which gave training, work experience, and some income to seven million young people in the 1930's.

Service to the community in some socially useful endeavor is the central idea of all national service programs, but such a program might be large or small and might be voluntary or mandatory. Thus there are four options to consider:

1. A small mandatory system. One possibility is a compulsory system in which a small number of participants would be drafted to participate in selected forms of civilian service. Such a plan seems so unlikely that it will not be discussed further.

2. A large mandatory system. Some European countries have required all young men to spend a year or more in the military, while others have required at least a year in either military or civilian service. It does not seem likely that such a program will be adopted by the United States, but its effect on the future flow of scientists and engineers will be considered briefly.

3. A small targeted system. A program of this kind would be voluntary but limited in scale and intended for a particular segment of the population, most probably for disadvantaged and minority youth who

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10 Reported in AAHE Bulletin, published by the American Association for Higher Education, Vol. 32, no. 4, December, 1979.

suffer high unemployment rates and who could benefit from a period of supervised service that would give them training, experience, and perhaps attitudes and work habits that would enhance their ability to enter the normal labor force upon completion of the period of national service.

4. A large voluntary program. Service would be voluntary and open to large numbers of young people, perhaps to all who wished to take advantage of the opportunity.

Mandatory Universal Service

Mandatory national service may be unconstitutional. Congress clearly has the power to conscript for military duty, but conscription for civilian service might be judged to constitute involuntary servitude. The Department of Justice has concluded that if civilian service is linked to military service, the mandatory civilian component would not constitute involuntary servitude. There is disagreement, however, and a mandatory program would surely be challenged and left to the courts to decide. The question is likely to go unanswered, for universal mandatory service has no supporting constituency and would have a hard time gaining Congressional support.

If, nevertheless, such a program were adopted, the effect on the flow of young scientists and engineers is easy to foresee. Everyone (except perhaps around 10 percent not qualified for the least demanding type of civilian service) would spend a period of time in military service or a probably shorter period in civilian service. Thus, there would be a delay of a year or two for each future scientist and engineer; but after the new system reached a steady state, the annual number of new scientists and engineers would be little affected, for the year of service would have become a normal -- even if not always welcome -- part of growing up.

Voluntary Targeted Service

At the other extreme in size would be a limited, voluntary civilian service program intended primarily to benefit disadvantaged youth by giving them job skills, a year of "maturing" experience and supervision, and work attitudes that would help them join the regular civilian labor force upon completion of their period of civilian service. Within that target population would be some young people with intellectual ability of a high order -- young people who, under the proper circumstances, could become scientists and engineers. However, the conditions that made them eligible for the program -- poverty of their previous education, motivation, environment, and opportunity -- would have already done their work; few of them would aspire to become scientists and engineers. On the other hand, young people who had decided they wanted to enter science or engineering would have defined themselves out of the target population for this kind of program. Thus, a voluntary, targeted program of civilian service would have essentially no effect on the future flow of scientists and engineers.

Broad Voluntary Service

The fourth type of national service program would be voluntary rather than mandatory and open to a wide range of young people rather than limited to a particular group. If such a program were adopted, the best available basis for estimating the effects upon the future supply of scientists and engineers seems to be the studies and analysis of Donald J. Eberly, a senior policy analyst at ACTION and Executive Director of the National Service Secretariat. His thinking and advice were highly influential in shaping the McCloskey Bill and its forerunner 10 years ago.[11]

The popularity of a civilian service opportunity would depend upon social and economic conditions, the pressure for military service, and other options open to young people. Under the conditions of 1968-1970, Eberly estimated that a civilian service program would expand within a few years to include over two million people.[12] Now, he estimates that a voluntary program open to all young people who choose to join would attract about one million. Because of the kinds of work involved, he expects 550,000 of the million to be women and 450,000 to be men. However, to build up to that size would take several years, for time would be required to arrange for the services to be performed, to secure the needed trainers and supervisors, and to develop the rest of the necessary infrastructure. Thus, he suggests that there might be 100,000 involved in the first year, 300,000 in the second year, and a million in the third and subsequent years.

On the basis of some small trial program, such as an ACTION-sponsored test of the national service idea in Seattle, he expects 400,000 of the million to be from the college group and 600,000 to be

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[11] Personal communication and several papers by Donald J. Eberly:

The Estimated Effect of a National Service Program on Public Service Manpower Needs, Youth Employment, College Attendance and Marriage Rates, and National Service Research Topics, New York: Russell Sage Foundation, January, 1970 (multiheaded);

"National Service: Alternative Strategies," Armed Forces and Society, Vol. 3, No. 2, May, 1977, pp. 445-456;

"The Educational Integrity of Community Service and the Need for Federal Support," New Directions for Higher Education, Vol. 18, Summer 1977, pp. 53-63;

Statement, in Hearings on Military Posture and H.R. 1872, U.S. House of Representatives, Committee on Armed Services, 96th Congress, 1st Session, March 12, 1979;

"A Call for National Service," Volunteer Action Leadership, Summer 1979, pp. 27-30;

Statement to the U.S. Senate Committee on Labor and Human Resources, Subcommittee on Child and Human Development, March 13, 1980.

[12] Donald J. Eberly, The Estimated Effect of a National Service Program, op. cit.

high school dropouts or high school graduates who do not plan to go to college. The 400,000 from the college group would include high school graduates who chose a year of civilian service before entering college, students who were taking time out from college, and a relatively small number of college graduates who chose to enter civilian service before going on to their more permanent occupations or to further education. In age, Eberly suggests that they might be distributed somewhat as follows:[13]

TABLE 3: Distribution in a voluntary civilian service program

Age	Men	Women
18	60,000	80,000
19	50,000	60,000
20	40,000	50,000
21	20,000	20,000
22 to 24	10,000	10,000
TOTAL	180,000	220,000

College students are always a diverse lot, and that civilian service would be equally attractive to prospective engineers, school teachers, economists, social workers, historians, dentists, etc., is doubtful. For several reasons, future natural scientists and engineers would probably be less likely than the generality of students to wish to enter civilian service. Most of them are more interested in academic work and some of them -- engineers, for example -- have their occupational plans already made and are eager to get on with their education. While many of the civilian service jobs would fit the career interests of prospective teachers, social workers, foresters, and health workers, there would probably be fewer such jobs for the prospective engineers and natural scientists.

It seems likely, therefore, that civilian service would be relatively less appealing to the future scientists and engineers than to the generality of students. How much less is a guess, but assume that future scientists and engineers would choose to enter civilian service with 75 percent of the frequency of all students. On this assumption, the 400,000 in the college group (some not yet entered, some taking time out, and a few already graduated) would include about 30,000 future scientists and engineers -- 18,000 men and 12,000 women. These 30,000 would constitute about 15-16 percent of the future scientists and engineers in each graduating class of the 1980s. The principal effect of the program would be to delay graduation by a year, or to delay entry into graduate or professional school or a first post-college job.

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[13] Donald J. Eberly, personal communication.

Some of the estimates on which the figure of 30,000 is based are quite uncertain. A national service program might attract more than 400,000 college students a year, or fewer. College students in the smaller age cohorts of future years may anticipate more attractive economic opportunities than have students of recent years and thus be less interested in spending a year in civilian service. In comparison with other students, future scientists and engineers may be more, or less, likely to enter civilian service than the 75 percent as the frequency ratio assumed here. Because of these uncertainties, there is a considerable, and unknown, range of error around the estimate of 30,000. But whatever the figure, the effect of the program on the future supply of scientists and engineers would be a delay of entry of a year or so for a roughly estimated one-sixth of those in each age cohort.

V. CIVILIAN SERVICE PLUS VOLUNTARY AND INVOLUNTARY MILITARY SERVICE

In 1979 and again in 1981, Representative Paul N. McCloskey, Jr., introduced a Congressional bill (H.R. 1730) that proposed to combine civilian service with plans for securing the necessary number of volunteers and draftees to meet military requirements. Other bills with similar objectives have been introduced in several sessions of Congress. None has been enacted, and the probability of early enactment seems small. However, Representative McCloskey's bill is a good example of the civilian plus military service idea and is the specific proposal that will be considered here.

Options

The McCloskey Bill would require each young man and woman at the age of 18 to select one of the four following options, although options 1 and 3 could be postponed a few years if the 18-year-old so chose:

1. Two years of military service at a subsistence wage (in 1979, proposed to be $200 per month in comparison with the base pay of $418 per month in the military services; the latter figure has since been increased to $501 per month). At the end of two years of military service, each person who chose this option would be entitled to four years of educational benefits of the kind offered by the GI Bill prior to the adoption several years ago of a contributory requirement for post-service educational benefits.

2. Six months of full-time military training followed by five-and-a-half years in the Reserve Force with an obligation to remain combat-ready and available to go into action immediately upon call.

3. A year of civilian service at a subsistence wage of perhaps $200 per month. The type of service could be selected by the volunteer. The McCloskey Bill includes no provision for educational benefits, but that provision might be added. Some advocates of civilian service recommend that it also carry entitlement to educational benefits but substantially less in amount than given to those who volun-

teer for military service. In fact, some advocates of civilian service argue that (a) some current programs of financial aid to college students are more generous to young people who stay out of the service than are the current, contributory, educational benefits for veterans, and (b) educational grants should normally be available only to those who have participated in military service or national service.

4. None of the above. Those 18-year-olds who decide not to take any of the other options would go into a draft pool, where for six years, until reaching age 24, they would be liable to be drafted if there were not enough volunteers to meet military needs.

Outcomes

These options are so different from any past system that there is little basis for estimating how young men and women would choose among the four. But if the McCloskey Bill were adopted, one immediate outcome is certain, and several others seem probable.

1. The annual number of new inductions (voluntary and involuntary) would increase substantially. In the All-Volunteer Force, volunteers enlist for three or four years. The McCloskey Bill calls for two-year enlistments. The 400,000 volunteers that have been necessary to maintain authorized strength would jump to 600,000 or more. The number would depend partly upon reenlistment rates. Under the McCloskey plan, reenlistment would bring very substantial increases in pay, but whether reenlistments would be sufficient to compensate for the fact that first enlistment would be for two years instead of three or four is uncertain. If reenlistments were not at a satisfactory rate, that the system would be permitted to continue is doubtful, for highly technological military services require a substantial fraction of the force to be better trained than is possible in two years. Whatever the actual number turned out to be, the McCloskey plan would require more new entrants than does the All-Volunteer Force; 600,000 a year instead of the present 400,000 can be used as one basis for estimating the effects of the plan on the future flow of scientists and engineers.

2. Because the pay would be much lower, voluntary enlistment would be less attractive than it is now to many of the non-college youth who join the All-Volunteer Force.

3. Because the educational benefits would be much more generous than they are now, voluntary enlistment would probably be more attractive to college-bound students than it is now.

4. For many students, national service for one year would be an attractive alternative to two years of military service, even if the civilian service option brought no educational benefits.

With so many uncertainties, estimating numerical effects is hazardous. Even the direction of some of the effects is uncertain. The authors of President Carter's 1980 report to Congress on selective service concluded that national service would be undesirable because it would not increase volunteering for military service. In contrast,

Donald Eberly reports that "some national service advocates, notably Amitai Etzioni and Reverend Theodore Hesburgh, contend that a long-run program of voluntary national service would obviate the need for a draft, since it would generate a spirit of service among young people that would result in a sufficient number of volunteers for military service."[14]

No experience is available to indicate how popular each of the four options would be among prospective scientists and engineers. When Congressman McCloskey asked a group of 115 student interns in Washington, D.C., how they would choose among the four alternatives, 66 chose the first option (two years of voluntary military service); six chose the second (six months of training and five-and-a half years of Reserve obligation); 43 picked the third option (a year of civilian service); and none selected number four (six years of vulnerability in the draft pool).[15] This group of student interns is far from being statistically representative of the college group, much less of the scientific and engineering proportion of that group. Tentatively, however, their responses suggest that volunteering for two years of military service with a resulting four years of educational benefits would be a popular alternative for students, at least initially. It might turn out that volunteering for two years of military service was so popular that going into the draft pool became a reasonably safe and popular option among students who wanted to get on with their education.

There are so many uncertainties and so little experience that quantitative estimates of the number of future scientists and engineers from each age group who would select each option is nothing more than a guessing game. However, as one guess, assume that (1) approximately 600,000 true volunteers plus draft-motivated volunteers would obviate the necessity for a draft, and (2) these 600,000 were so divided as to achieve an armed force statistically representative of all educational, socio-economic, and majority/minority segments of the population. Actually, the achievement of that distribution would be possible only if volunteering were not permitted and all entrants into military service were selected by a random draw from the eligible pool, a procedure completely negated by the McCloskey plan options. However, if that distribution were achieved, 43 percent -- or 242,000 volunteers -- would be from the college group.

If, in addition, the 180,000 college men and 220,000 college women assumed to enter a free-standing civilian service each year also chose this option under the McCloskey plan, then the total military and civilian service group would include nearly half of the men and a quarter of the women who now enter degree-credit programs each year. Using, as previously, the assumptions that civilian service would be three-quarters as popular among future scientists and engineers as among all college students and that volunteering for military service

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14 Donald J. Eberly, "A Call for National Service," page 28.

15 Reported by Neal R. Pierce, "Needed: Universal Service," The Atlanta Constitution, March 6, 1980.

would be as popular among future scientists and engineers as among all college men leads to the estimate that 64,000 -- or 32 percent -- of the future scientists, engineers and members of other technical professions in each age group would choose to spend a year or two in military or civilian service. Projecting ahead to the smallest age group, in 1994, the same absolute numbers would constitute almost 40 percent of the future scientific and technical group from each age class.

Is the temporary withdrawal of this large a fraction of the group under analysis likely? Probably not. The numbers used for illustrative purposes are quite uncertain. The whole program seems quite unlikely under present conditions. And, if, nevertheless, a bill of the McCloskey type were adopted, it would be phased in gradually; and after the first year, returnees would partially offset, and later largely offset, the number withdrawn.

Even if the plan were adopted and something like the illustrative numbers turned out to be involved, the primary effect upon the future flow of entrants into scientific and technical professions would be that a substantial number had taken a year out for civilian service and that another substantial number had taken out two years for military service and had then returned with generous educational benefits to permit them to go on with the education necessary for entrance to their chosen fields of work.

VI. REASONABLENESS OF THE ESTIMATES

There is some basis for appraising the reasonableness of the estimated effect of a Selective Service draft. The assumed figure of 150,000 draftees a year is, as mentioned earlier, equal to the greatest number drafted in any of the peacetime years from 1961 to 1965 and more than double the number inducted in some of those years.

The calculated estimate that an annual draft of 150,000 men would include 11,000 who would be expected to enter scientific and professional occupations should be compared with the uncertainty in the projections of how many college graduates there will be in the years ahead. For the academic year 1983-84, the 11,000 estimate equals about 12 percent of the spread between the low and high projections made by the National Center for Education Statistics of the number of bachelor's degrees to be awarded in scientific and technical fields.[16] For the year 1988-89, the 11,000 estimate represents about eight percent of the spread between the low and high projections. Uncertainty concerning the number of future entrants into scientific and technical occupations who would be affected by a draft seems small compared with the uncertainty as to how many degree recipients there will be in those fields in the rest of this decade.

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[16] Martin M. Frankel and Debra E. Gerald, Projections of Education Statistics to 1988-89, Washington, D. C.: U.S. Government Printing Office, 1981.

As another check on their reasonableness, the estimates made here should be compared with those in the companion paper by Richard Cooper, whose more detailed analysis of a range of possible Selective Service scenarios led to qualitatively similar conclusions.

VII. OTHER EFFECTS

Any of the programs discussed here would result in a drop in college enrollment, a drop superimposed on the reduction in enrollment that is expected as a result of the smaller birth cohorts now reaching the age of college entry. The size of the drop would vary greatly from college to college. Some selective institutions always have more applicants than they can accept, while others have trouble filling their classes even without a draft or a civilian service program to compete with student recruitment. In general, however, the drop would be temporary. Students returning from military or civilian service would soon begin to offset those newly being withdrawn.

Effects on Individual Students

If a few students are drafted for military duty while the rest of their classmates continue with their education, the few have lost two years. If everyone spent two years in military or civilian service, nobody would have lost time in comparison with others. The programs described above fall between these two extremes. The lost-time problem would be less acute the larger the number withdrawn, but it would not disappear under any of these possible programs.

In either civilian or military service, the feeling of having lost time would probably be lessened by the fact that the young people would be working with many more actual or prospective college students than would otherwise have been in the All-Volunteer Force, and by the fact that many would have been assigned to duty or specialized training of their own choice or of a nature related to their career interests.

It is also interesting to speculate that a draft or a national service program might improve the education of those who have already served their time in military or civilian service. Not everyone who is in college really wants to be there; they are in college because more interesting opportunities are not open to them. A draft would remove some of these students, and a national service program or a McCloskey Bill program would remove more. Moreover, some who were relatively uninterested before they left would be more interested after their service. As a result, for the students on campus, classes might be less diluted by uninterested classmates and, from an educational standpoint, might be the better for it.

Effects on Individual Fields

All of the above analyses have been in terms of the highly aggregated group of college students who earn baccalaureate degrees in any

scientific or technical fields. How many of those graduates actually enter scientific or technical occupations depends on a variety of factors: their own career plans, job openings, and alternative opportunities. In recent years, about 56 percent of the men and 36 percent of the women earning degrees in scientific or technical fields have entered scientific or technical occupations. Even fewer have entered the same field of work as the field of their degrees, for there is considerable mobility, for example, of engineers, mathematicians, and some others into the tight field of computer technology.

Thus, overall, there is a substantial margin, or adjustment range, between earning degrees in the scientific and technical fields and entering employment in those fields. If Selective Service, civilian service, or a McCloskey-type plan temporarily withdraws considerable numbers of students who otherwise would have entered scientific or technical work a year or more earlier, and if economic conditions create a high demand for young scientists or engineers, there will be other graduates with similar training available so the market can adjust.

However, the margin between degrees and employment is quite different in different fields. Six years after receiving the bachelor's degree, about 80 percent of engineering graduates who are employed anywhere are working in a scientific or engineering field, while among social science graduates, fewer than 20 percent are working in a scientific or technical field.[17] Thus, there is much more room for adjustment to increased market demand in the social sciences than in engineering. In a period of high demand, such as currently exists for young engineers and computer specialists, withdrawal of significant numbers of students for military or civilian service would tend to raise salaries. Under the anticipated economic conditions of the rest of this decade, that is unlikely to be the case for the other scientific and technical occupations.

VIII. CONCLUSION

A Selective Service draft, a broad and voluntary civilian service program, or the combination of military and civilian service programs envisaged in the McCloskey Bill would all result in a temporary dip in the number of college graduates qualified for employment in the scientific and technical professions. In most of those fields, however, degrees are awarded to substantially more graduates than those who enter employment in scientific or technical work.

After a year or two, students returning from their military or civilian service would approximately offset those being newly withdrawn; and after an initial period of adjustment, the flow of college graduates into scientific and technical occupations would approximate

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[17] National Science Foundation, "Employment Characteristics of Recent Science and Engineering Graduates," Reviews of Data on Science Resources, NSF 80-311, No. 36, May, 1980.

the otherwise expected levels. The change in the nation's total stock of scientists and engineers would probably be too small to measure.

The relative merits of the All-Volunteer Force and Selective Service can be debated on other grounds, and so can the merits of a civilian service program or a McCloskey-type program. But their effect on the future supply of college graduates for scientific or technical work cannot be used as a strong argument for or against any of these military procurement policies or civilian service programs.

MILITARY MANPOWER PROCUREMENT POLICY

AND THE SUPPLY OF SCIENTISTS AND ENGINEERS*

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I. INTRODUCTION

For nearly eight years now, since the draft was ended in 1973, the nation has relied on the All-Volunteer Force (AVF) to fill the ranks of the military. The success of this endeavor has been and continues to be widely debated in public circles. While some have considered the AVF an outright failure, others, including this author, have viewed the AVF "experiment" to be largely successful. One thing that has become clear during these past eight years is that military manpower procurement policy will likely continue to be a major issue as declining youth cohorts will make attracting the requisite numbers and kinds of personnel more difficult for the military. This, combined with the almost naturally controversial nature of military manpower procurement policy, will likely keep the AVF in the mainstream of public concern. For all the debate about the present volunteer force, however, the debate itself has tended to focus rather narrowly on issues associated with recruiting and the kinds of young people joining the military. Only recently has the debate begun to broaden much to consider the implications of military manpower procurement policy upon the military in general or, for that matter, on society as a whole. Yet, this is precisely where some of the most important effects of military manpower policy will be felt.

This paper attempts to deal with one of the possible by-products of military manpower-procurement policy -- in particular, its effect on the supply of scientists and engineers. The specific purpose of this paper is threefold: (1) to develop an analytical framework for addressing the effects of military manpower procurement policy on the future supply of scientists and engineers; (2) to explore the possible effects under several alternative scenarios; and (3) to establish a research agenda for determining more precisely what these effects might be under a wide range of alternative circumstances.

The next section of this paper focuses on my approach to the problem. This is followed, in Section III, by the development of a specific methodology for estimating the effects of military manpower procurement policy on the future supply of scientists and engineers. Section IV examines the consequences of some different possible scenarios on the future supply of scientists and engineers while conclusions and recommendations for further research are presented in the last section.

II. APPROACH TO THE PROBLEM

To determine the effects of potential changes in military manpower procurement policy upon the future supply of scientists and engineers, we need first to understand four aspects of the problem:

- The relationship between military manpower procurement and the supply of scientists and engineers

- The key parameters of the science and engineering (S&E) supply process

- The key military manpower procurement policy variables

- Possible military manpower procurement policy scenarios.

The following section builds on this general framework and develops a more specific methodology for estimating the effects of military manpower procurement policy on the future supply of scientists and engineers.

Analytical Framework

Even in the absence of a draft, the relationship between military manpower procurement and the future supply of scientists and engineers is complex, as illustrated by the simplified schematic presented in Figure 2-1. Assuming that those who graduate from high school do so when they are 18 years old, we can sort 18-year-olds into two groups: high school graduates (about 71 percent of the male population) and non-high school graduates (29 percent). High school graduates can, in turn, be grouped into one of three categories: (1) those who go to college (about 63 percent of high school graduate males); (2) those who enlist in the military (about 15 percent); and (3) the remainder (about 22 percent), including those working, unemployed, and in leisure activities. Those who go to college fall into two groups: graduates (about 51 percent) and dropouts (49 percent). College graduates likewise fall into two groups: those who remain in the civilian world (about 95 percent) and those who enter the military as officers (5 percent) through the military academies, ROTC, or Officer Candidate School (OCS). Finally, of civilian college graduates, approximately 48 percent earn degrees in scientific or engineering areas.

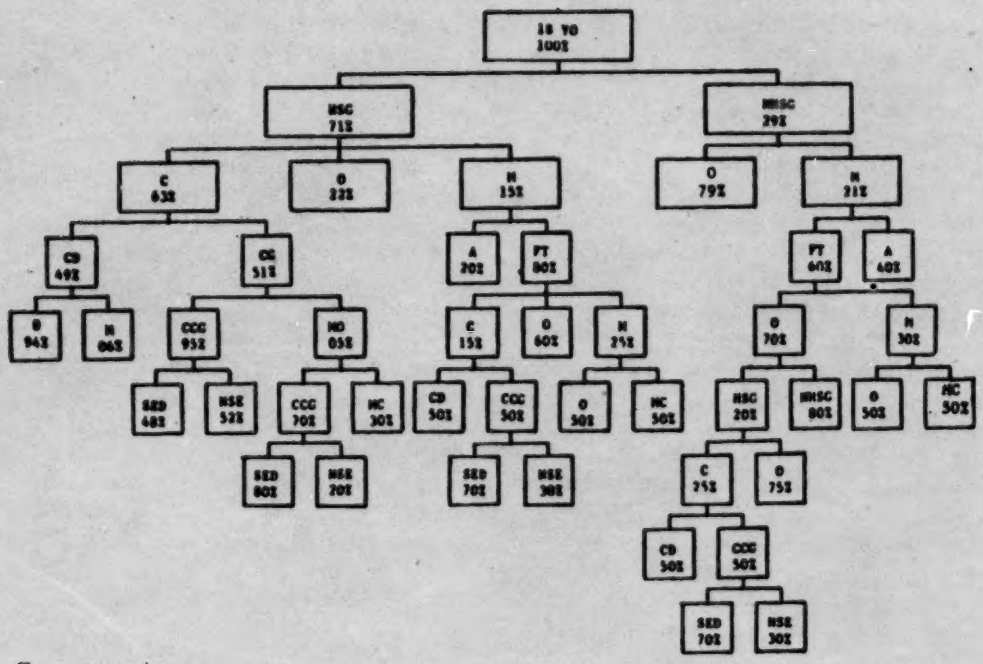
The above describes the main flow for civilian college graduates with degrees in scientific or engineering fields. However, Figure 2-1 shows that the military provides at least three other sources of such individuals: (1) college graduates who join the military (usually as officers) but return to the civilian sector after their first term of duty; (2) high school graduates who go to college after leaving the military (often using educational benefits resulting from their military service); and (3) non-high school graduates who, as a result of their military service, complete high school and then go to college. Using the estimates (and "guesses") shown in Figure 2-1, a 2-million-member male age-cohort would be expected to yield the following numbers of scientific and engineering degree graduates from the four sources just outlined:

- Civilian route: 208,000

- College graduate, military officer: 13,000

- High school graduate, military enlisted: 9,000

FIGURE 2-1: Schematic of relationship between military manpower procurement without a draft and supply of scientists and engineers



Legend

18YO: 18-yr-old male population	CCG: civilian college graduates
HSG: high school graduates	MO: military officers
NHSG: non-high school graduates	MC: military careers
C: college	SED: S&E degrees
M: military	NSE: non-S&E degrees
O: other (work, leisure, etc.)	FT: complete first military term
CG: college graduates	A: do not complete first term
CD: college dropouts	

- Non-high school graduate, military enlisted: 1,000 or fewer.

Thus, while the strictly civilian route is the dominant source of S&E graduates, about 10 percent of young S&E graduates come to the civilian sector via the military.

The above relationship is complicated considerably, especially from an empirical viewpoint, by the introduction of a draft. To understand these effects, we need first to consider how a draft would operate. Among other things, the draft "reforms" of the late 1960s shifted draft policy from an "oldest first" to a "youngest first" basis,[1] making 20-year-olds the vulnerable age group.[2] Thus, the typical college student would be vulnerable just prior to his junior year. Those actually inducted would then return to their junior year after serving two years as draftees. Equally if not more important than draftees themselves are draft-motivated volunteers, individuals who would not join the military in the absence of a draft but who enlist to avoid being inducted. Although enlistees must serve longer than draftees (three years in the Army and Marines and four years in the Navy and Air Force), enlistees have some choice regarding time of entry, branch of service, and their actual job assignment. Because of these advantages, many individuals who would not enlist in the absence of a draft in fact do so under a draft to avoid the chance of being inducted. Indeed, we estimate that there were more draft-motivated enlistments than there were inductions during the post-war draft. In addition to draftees and draft-motivated volunteers, conscription also leads to conscientious objectors (COs), individuals who refuse to serve in the military for moral or religious reasons. Under the law, COs can be required to serve an equivalent amount of time (two years) in non-military duty -- i.e., alternative service such as hospital orderly or day-care worker. Although the alternate-service program has been administered unevenly in the past, present Selective Service plans call for a more consistent, vigorous, and evenly-administered program should a draft ever be reinstated. Finally, if a draft is accompanied by an increased officer corps, we find more college students entering ROTC units, thus obligating themselves to at least one term (two to six years, depending on the branch of Service and occupational specialty). Thus, the introduction of a draft has four additional effects on college-bound youth: (1) some will be drafted, probably around their junior year; (2) some will join the military as draft-motivated enlistees, either before entering college, during their freshman year, during their sophomore year, or early in their junior year; (3) some conscientious objectors will be required to perform alternate service, probably around their junior year; and (4) more

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[1] These reforms had two other important aspects. The first changed the period of vulnerability from eight years (18-26) to one. The second was the elimination of most deferments.

[2] Actually the period of vulnerability is stated in terms of year of birth, not age. Thus, the individual is vulnerable during the calendar year in which he turns 20 years old.

college students will enter ROTC and thus be required to serve in the military upon graduation. These four effects complicate considerably the relationship between military manpower procurements and the supply of scientists and engineers.

Key Factors in the S&E Supply Process

The second step in evaluating the effects of military manpower procurement policy on the future supply of scientists and engineers is the S&E supply process itself. In this regard, structuring the analysis in terms of those factors that might be affected by changes in military manpower procurement policy is useful. Viewed from this perspective, there are five key factors that comprise the S&E supply process:

1. Size of the manpower pool (the numbers of high school graduates available to enter college). To the extent that college-bound youth are either drafted or serve as draft-motivated enlistees, the future supply of scientists and engineers will obviously be diminished. However, these individuals return to the pool of potential college students upon the completion of their two-, three-, or four-year period of service.

2. Percent bound for college. We would expect fewer draftees and draft-motivated enlistees to attend college than would have in the absence of a draft, given that the opportunity cost of attending college is likely to increase as the individual gets older. That is, a draft is likely to reduce college participation rates in the long run, as some individuals are removed from the college market for two to four years. If, however, a draft were to be accompanied by additional educational benefits such as the GI Bill, both the opportunity cost and out-of-pocket expenses associated with college attendance would be reduced, thus helping to offset the otherwise lower college participation rates likely to result from a draft; in fact, a GI Bill might actually result in a net increase in college participation rates among those serving.

3. Percent completing college. Although a draft might reduce college participation rates among those who are drafted or who serve as draft-motivated enlistees, it might well increase the completion rates for those who eventually return to college, since those who had thus served in the military would be older and presumably more mature when returning to school and, therefore, more likely to finish. To the extent that some students drop out of college as a result of inadequate financial resources, the number completing college would be increased further by the presence of a GI Bill.

4. Percent receiving degrees in S&E. We might expect the more technical nature of military service to increase the proportion of college graduates having degrees in S&E fields.

5. Percent entering the S&E professions. Again, we might expect

the more technical experience acquired in the military to increase the proportion of S&E graduates who actually enter S&E professions.

Thus, the number of future S&E professionals out of a given age-cohort is simply equal to the size of the manpower pool, times the percent entering college, times the percent completing college, times the percent with S&E degrees, times the percent entering S&E jobs. Because military manpower procurement policy has a differential effect on men and women, it will be argued later that it is necessary to consider these processes separately for men and women. Nevertheless, the same basic process holds for both sexes.

Key Military Manpower Procurement Policy Variables

The effect of military manpower procurement policy upon the future supply of scientists and engineers depends on much more than simply whether a draft is used. Also important are the key military manpower policy variables vis-a-vis the future supply of scientists and engineers discussed below:

1. Force sizes. Perhaps the most important policy variable is force size and the resulting enlisted accession requirements (i.e., the demand for new recruits). This includes both the size of the military and the contemplated time for increases in military strength -- i.e., the rapidity with which such increases take place. Obviously, larger and/or more rapid increases in force sizes will have a larger effect on the future supply of scientists and engineers.

2. Draft policy. Key to the effects on the future supply of scientists and engineers is the policy toward deferments and exemptions. Although a return to such policies as deferments for students and fathers or because of marriage is unlikely, there would likely still be a number of legal ways to avoid serving in the active military. One of the most common forms of draft-avoidance during the early seventies was serving in the reserves. Although this still requires some form of military duty, college students in the reserves, for example, would likely be able to complete their studies and post-education employment almost uninterrupted. To the extent that service in the reserves, for instance, provides an exemption from the draft, it will be argued later that the impact of a draft will be less for college students than for other individuals. (Indeed, this accounts for the fact that 56 percent of reserve enlistments in 1971-1972 were college educated!) Alternatively, eliminating such draft-avoidance exemptions would increase the impact of any given draft on college students and the future supply of scientists and engineers.

Another element of draft policy that needs to be considered is the specification of the vulnerable age-group. Although the present law specifies 20-year-olds as the vulnerable age-group, one should note that during the transition to a "youngest first" draft policy in 1969, all 20- to 26-year-olds were equally vulnerable. The rationale for this was that, in shifting from an "oldest first" to a "youngest

first" draft, those under 26 but older than 20 should not be able to escape their obligation entirely. Should such a policy again be adopted in the event that conscription is reinstated, this would mean that all 20- to 26-year-olds would be equally vulnerable during the first year of the draft. Thereafter, the prime vulnerability would shift to 20-year-olds. The importance of this as a policy issue rests in the immediacy of the effects caused by the draft. To illustrate, should a draft be limited to 20-year-olds from the outset, then the effects of a draft would not be felt on S&E supply for two years (barring any increase in the officer force), since those beyond their junior year would not be vulnerable to the draft or the threat of a draft. On the other hand, extending the vulnerability equally to all 20- to 26-year-olds would result in an immediate effect on the supply of scientists and engineers.

3. Military pay. To the extent that military pay is reduced, there will be fewer true volunteers joining the military. This means that, to fill enlisted accession requirements, there will have to be more inductions and/or draft-motivated enlistments, which correspondingly would increase the impact on the future supply of scientists and engineers. During the 1960s, military pay for junior enlisted personnel was 30 to 40 percent below the amount earned by similarly aged and educated individuals, as opposed to the roughly comparable level that today's enlistees enjoy.

4. Enlistment quality standards. To the extent that the military raises the minimum standards for entrance into the military, there will be a corresponding effect on the future supply of scientists and engineers. First, raising quality standards above today's levels would mean that fewer of today's volunteers would qualify, thus increasing the requirement for draftees and draft-motivated enlistees. Second, more non-college students than college students would be disqualified by such an increase in standards so that college students would make up a larger proportion of the eligible manpower pool, thus increasing the chances of their having to serve.

5. Education opportunities. To the extent that higher education assistance is tied to some form of military or public service, as advocated by some, or that educational benefits from military service are increased, more individuals will serve in the military, and fewer will attend college, at least in the near term.

6. Women. Under present law, only young men are subject to the draft. Extending the draft to women would reduce the impact of any given draft on the future supply of scientists and engineers. Although such a change might not alter the total number of draftees or draft-motivated enlistees, fewer women enter the scientific and engineering fields so that replacing some male draftees and draft-motivated enlistees with women would lessen the impact on the future supply of scientists and engineers.

7. Conscientious objectors. Although present Selective Service plans call for a more vigorous alternative-service program than in

prior periods of conscription, the exact shape of this policy has not yet been determined. At least three main options are being considered, the effect of which on S&E supply could differ substantially. Perhaps the most likely policy would result in those COs who would otherwise qualify for military service having to perform alternate service. A second option that has been considered would require all or most all COs whose lottery number had been selected to serve, irrespective of their mental and medical qualifications for military duty. Since about 40 percent of male 18-year-olds do not meet the military's minimum standards of enlistment, the second option would result in about 67 percent more COs in alternate service than would be the case under the first option.[3] Third, some consideration has been given to holding two lotteries, one for military service and one for COs; the military lottery would be driven by the military's induction requirements while the CO lottery would be determined by the availability of alternate-service jobs. Since the military's requirements for inductees would probably increase more rapidly than the availability of alternate-service jobs, at least initially, this third option would likely result in fewer COs serving in an alternate-service program than would be the case under the first option.

The above discussion thus emphasizes the importance not only of considering whether a draft is instituted, but also its size, its type, and other related military manpower policy variables. These will be addressed explicitly in the analysis.

Scenarios

Given the uncertainty about what military manpower policy will be -- and the importance of such policy variables as force size, pay, and quality standards -- it is useful to couch the analysis here in terms of a variety of different cases or scenarios. Such an approach serves to highlight the effects of different possible military manpower procurement policies on the future supply of scientists and engineers.

To begin, the analysis conducted here is presented relative to the base case, which simply assumes that present policy remains unchanged -- that is, an AVF with comparable pay, the same quality standards as now, and so forth. The hypothetical alternatives examined are described below:

Case I: Draft; 2.0-million-man force (i.e., the same as today); and no other manpower policy changes (i.e., present policies toward pay, quality standards, etc., remain unchanged).

Case II: Draft, 2.0-million-man force; higher quality standards; and no other policy changes. "Higher quality standards" is inter-

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[3] That is, if x percent of the population are COs, then 100 induction notices result in x COs performing alternative service under the second option, as opposed to $0.6x$ under the first.

preted to mean that the ceiling on non-high school graduate and/or Mental Category IV enlistments will be reduced from 45 percent to 25 percent.[4]

Case III: Draft; 2.5-million-man force (increase enlisted strengths by 460,000 and officer strengths by 40,000); and no other manpower policy changes.

Case IV: Draft; 2.5-million-man force; higher quality standards; and no other policy changes.

Case V: Draft; 2.5-million-man force; first term pay reduced by 10 percent the first year, 20 percent the second and 30 percent thereafter;[5] and no other policy changes.

Case VI: Draft; 2.5-million-man force; first-term pay gradually reduced by 30 percent as in Case V; reduced exemptions (e.g., no exemption for reserve service); no other policy changes.

Case VII: Draft; 3.0-million-man force (increase enlisted strengths by 900,000 and officer strengths by 100,000); 6- to 8-year force buildup; first-term pay gradually reduced by 30 percent as in Case V; and no other policy changes.

Case VIII: Same as Case VII, except with prime vulnerability shared equally by all 20- to 22-year-olds for the first year (as opposed to just 20-year-olds).

Case IX: Mobilization; draft; 3.2-million-man force (increase enlisted strengths by 1.1 million and officer strengths by 100,000); 3-year buildup; gradually reduce first-term pay by 30 percent; no other policy changes.

Case X: McCloskey-type national-service draft; 2.5-million-man military; 4-year buildup in civilian national service to 200,000 college students; 30 percent reduction in first-term military (and civilian) pay; no other policy changes.

Case XI: AVF; educational benefits tied to some form of military or civilian service; expanded GI Bill for military; no other policy changes.

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[4] It should be noted that this 25 percent ceiling on the sum of Category IV and non-high school graduate enlistments is substantially more restrictive than has ever been used in the past. During the 12 years preceding the AVF, for example, the Services averaged about 45 percent.

[5] That is, it is assumed that first-term pay is held constant in nominal terms of the first three years, while civilian wages increase. Thus, the relative wages for first-termers decline to 90 percent of civilian wages for the first year, 80 percent the second, and 70 percent thereafter.

As will become clear from the analysis presented in Section IV, the above 11 cases provide an interesting array of hypothetical policy alternatives for estimating the effects of military manpower procurement policy on the future supply of scientists and engineers. As such, these cases are not intended to reflect the full range of policy alternatives. Rather they are intended to illustrate the possible effects of different specific policies and the interaction among policies.

III. METHODOLOGY

The last section described in general terms the relationship between military manpower procurement policy and the future supply of scientists and engineers and the kinds of factors that must be taken into account when evaluating the effects of alternative military manpower procurement policy options. This section develops a specific methodology for estimating these results, beginning with a model of military manpower supply under alternative procurement policies -- that is, true volunteers, draft-motivated volunteers, draftees, and conscientious objectors. Next, a model for translating these military manpower results into the effects on the future supply of scientists and engineers is developed. Finally the assumptions underlying the analysis are presented.

Military Manpower Supply

We can begin by estimating what enlisted accession requirements would be under the different cases to be examined. These are provided in Tables A-1 and A-2 on pages 76 and 77. Next, we must determine the numbers of true volunteers that will be forthcoming. True-volunteer estimates, based on some of my earlier work,[6] are also shown in the Appendix tables. The differences between requirements and true-volunteer enlistments, if the former exceeds the latter, must be made up from some combination of draft-motivated enlistments and inductions. The analysis presented here is based on the assumption that draft-motivated enlistments equal inductions in a given year; in other words, the difference between requirements and true volunteers is shared 50-50 by draft-motivated enlistments and draftees.[7]

Given the above, Figure 3-1 provides a simple schematic for determining military manpower supply. To begin, it is useful to break a given population cohort into four groups: (1) college-bound youth who

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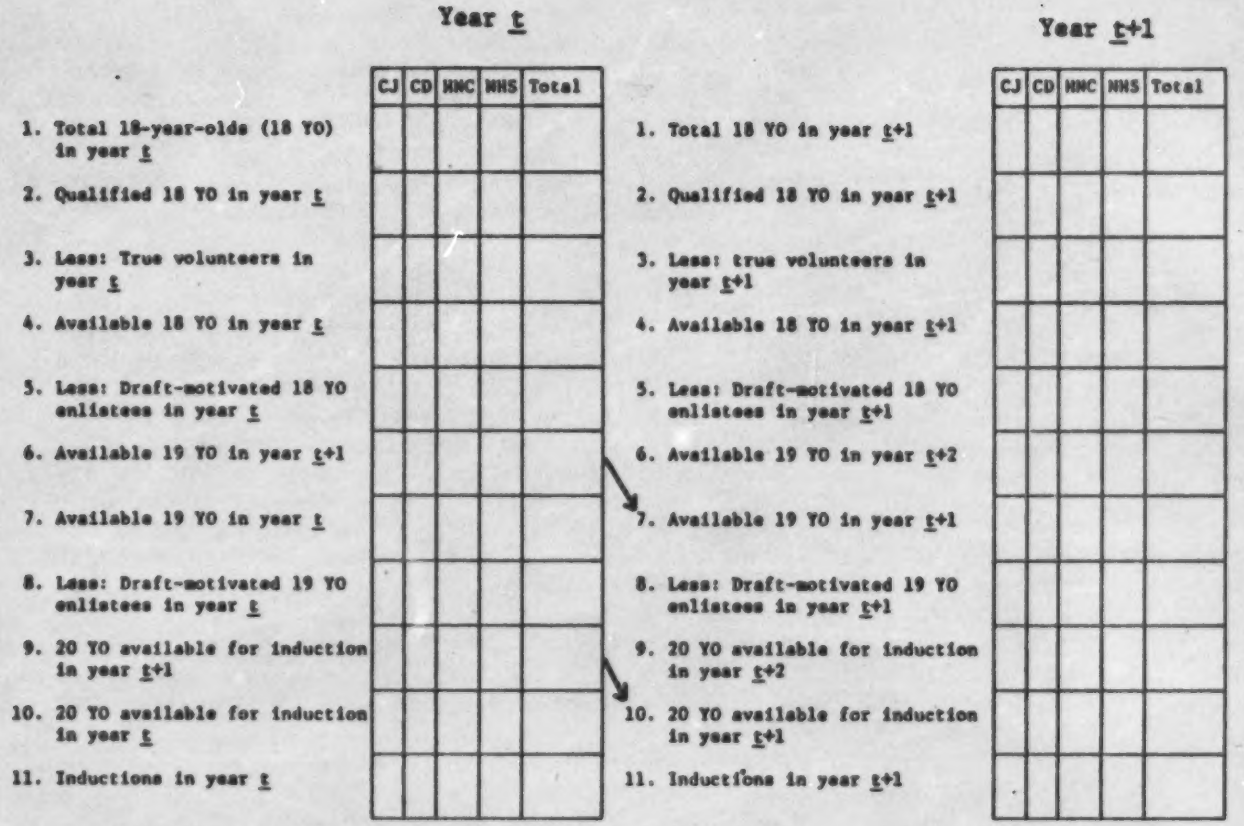
[6] See Richard V.L. Cooper, Military Manpower and the All-Volunteer Force, Rand Corporation, September 1977.

[7] Between 1956 and 1970, draft-motivated volunteers comprised about 53 percent of the sum of draft-motivated volunteers and draftees. See Cooper, op. cit., p. 20.

FIGURE 3-1: Model of military manpower supply


Year t
Year t+1
CJ
CD
NNC
NHS
Total
1. Total 18-year-olds (18 YO) in year t
2. Qualified 18 YO in year t
3. Less: True volunteers in year t
4. Available 18 YO in year t
5. Less: Draft-motivated 18 YO enlistees in year t
6. Available 19 YO in year t+1
7. Available 19 YO in year t
8. Less: Draft-motivated 19 YO enlistees in year t
9. 20 YO available for induction in year t+1
10. 20 YO available for induction in year t
11. Inductions in year t
1. Total 18 YO in year t+1
2. Qualified 18 YO in year t+1
3. Less: true volunteers in year t+1
4. Available 18 YO in year t+1
5. Less: Draft-motivated 18 YO enlistees in year t+1
6. Available 19 YO in year t+2
7. Available 19 YO in year t+1
8. Less: Draft-motivated 19 YO enlistees in year t+1
9. 20 YO available for induction in year t+2
10. 20 YO available for induction in year t+1
11. Inductions in year t+1

CJ: College students who would otherwise reach their junior year
CD: College students who drop out prior to their junior year
NNC: Non-college high school graduates
NHS: Non-high school graduates

will in fact reach their junior year; (2) college-bound youth who will drop out of college prior to their junior year; (3) high school graduates who do not go to college; and (4) non-high school graduates. Line (1) of Figure 3-1 distributes the total 18-year-old male population for a given year according to these four categories. (The assumptions regarding this distribution are given later in this section.)

In order to qualify for either enlistment or induction, the individual must meet certain mental, medical, and moral standards. Line (2) then shows those qualified for military service, based on the assumptions about qualification presented later in this section.

Given the number of true volunteers, and assuming that about 65 percent of those are high school graduates (of which about 10 percent are college dropouts), line (3) shows the number of true volunteers distributed according to CD, HNC, and NHS.

Line (4) is simply line (2) less line (3) and is, thus, the number of qualified 18-year-old males potentially available for induction or draft-motivated enlistment.

Line (5) shows the number of 18-year-old draft-motivated enlistees in a given year out of the 18-year-old male cohort. For simplicity, we assumed that two-thirds of draft-motivated enlistees in a given year are 18 years old when they enter the military, and the remaining one-third are 19 years old. (The total number of draft-motivated enlistments, recall, is simply equal to one-half the difference between total accession requirements and the number of true volunteers.) To distribute 18-year-old draft-motivated enlistments according to the four categories of qualified 18-year-olds -- i.e., CJ, CD, HNC, and NHS in Figure 3-1 -- we make the following key assumption: college students who would otherwise reach their junior year (CJ in Figure 3-1) are two to three times less likely to volunteer as draft-motivated enlistees than the other three categories of individuals. The rationale for this is that college students who would otherwise reach their junior year have the most to gain by not serving and are thus less likely to serve.[9]

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[8] The specific assumptions regarding the likelihood of becoming draft-motivated volunteers vary by case and are given later in this section. Note that this explains part of the rationale for distinguishing between CJ and CD in Figure 3-1. We assumed that college students who would otherwise reach their junior year are more "serious" about obtaining a college education and are thus less likely to serve in the military.

[9] The estimates used are based on some of my earlier work (see Cooper, op. cit., Chapter 5), which, in turn, is based on Larry Sjaastad and Ronald Hanser, "The Conscription Tax: An Empirical Analysis," in Studies Prepared for the President's Commission on an All-Volunteer Armed Force, U.S. Government Printing Office, 1970.

Line (6), which equals line (4) less line (5), is those eligible to enlist as 19-year-old draft-motivated volunteers one year later. That is, draft-motivated 19-year-old enlistees in year t+1 must be drawn from those qualified and available 18-year-olds in year t who did not earlier enlist. Line (7) is the pool of 19-year-olds available to enlist as draft-motivated volunteers in year t and is thus equal to line (6) from year t-1; or as shown in Figure 3-1, line (7) for year t+1 equals line (6) for year t.

Line (8) shows the number of 19-year-old draft-motivated enlistees in year t. (Recall that total 19-year-old draft-motivated enlistments were assumed to be one-third of all draft-motivated enlistments.) These are distributed into the four categories of qualified and available 19-year-olds according to the same assumptions used to distribute 18-year-old draft-motivated volunteers.

Line (9), which equals line (7) less line (8), is those eligible for induction one year later. In other words, inductions in year t+1 must be drawn from those qualified 19-year-olds in year t who did not earlier enlist (or join ROTC).

Line (10) is the pool of qualified 20-year-olds available for induction in year t and is thus equal to line (9) from year t-1; or as shown in Figure 3-1, line (10) for year t+1 equals line (9) for year t.

Finally, line (11) shows the number of inductions in a given year. (Note again that the total number of inductions is simply equal to one half the difference between accession requirements and the number of true volunteers.) To distribute total inductions among the four categories of qualified and available 20-year-olds, we again make the following key assumption: college students who have successfully reached their junior year are about one-and-a-half times less likely to be inducted than the other three categories of individuals, unless all legal methods of draft avoidance such as exemption for reserve service are successfully eliminated. Again, the rationale for this assumption is that college students have more to gain by not serving than their non-college peers, other things equal, and thus are more successful in avoiding at least active military service.[10]

Given the population trends and military qualification rates presented later in this section, the above discussion thus provides a method for determining the impact of military manpower policy on who actually serves under different scenarios. The discussion below pro-

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[10] This is given considerable empirical support from some earlier analyses of mine which show that even during the lottery draft from 1969 to 1972, when draft loopholes were substantially reduced, individuals from high-income areas stood only about half the chance of being inducted as those from low-income areas. See Richard V.L. Cooper, "Military Manpower Procurement Policy: Equity, Efficiency, and National Security," in Proceedings from the Hoover-Rochester Conference on the All-Volunteer Force, forthcoming.

vides a methodology for translating this impact into the effects on the future supply of scientists and engineers.

Supply of Scientists and Engineers

Based on the incremental military manpower procurement results derived from the military manpower supply model just presented, we can proceed to estimate the effects of changes in military manpower procurement on the future supply of scientists and engineers. To begin, we will assume that military manpower policy does not alter individual behavior. For example, if an individual who would have gone to college in the absence of a draft instead enlists as a draft-motivated volunteer, we will assume that he does in fact go to college upon the completion of his military service. Later, this assumption will be relaxed to consider the effects when military manpower policy alters an individual's college-going behavior.

The effects of military manpower policy on freshman enrollment can be estimated as follows:

$$\Delta F_t = \Delta CJDM18_t + \Delta CDDM18_t \qquad (3.1)$$

where

$$\Delta CJDM18_t = -CJDM18_t + 0.5\ CJDM18_{t-3} + 0.5\ CJDM18_{t-4}, \qquad (3.1a)$$

$$\Delta CDDM18_t = -CDDM18_t + 0.5\ CDDM18_{t-3} + 0.5\ CDDM18_{t-4}, \qquad (3.1b)$$

and where

ΔF_t = change in college freshmen enrollment in year t,

$CJDM18_t$ = individuals who would have gone to college and eventually reached their junior year in the absence of a draft but who, instead, enlist as 18-year-old draft-motivated volunteers in year t, and

$CDDM18_t$ = individuals who would have become college dropouts in the absence of a draft but who, instead, enlist as 18-year-old draft-motivated volunteers in year t.

That is, freshman enrollment in a given year is decreased to the extent that individuals who would have gone to college in the absence of a draft instead enlist as draft-motivated volunteers. After these individuals have served their three- or four-year enlistment tours,

they then return to college; hence, freshman enrollment is increased by this amount three and four years later. (The model presented here is based on the assumption that half of draft-motivated enlistees serve three-year terms in the Army or Marines while the other half serve four-year terms in the Navy or Air Force.) Note that a draft does not have a direct effect on freshman enrollment, insofar as induction is limited to 20-year-olds; rather, it has the indirect effect of encouraging draft-motivated enlistments.

A draft has two effects on college sophomore enrollment: (1) individuals who have completed their freshman year and who would have become sophomores but instead joined the military as 19-year-old draft-motivated volunteers, and (2) 18-year-old draft-motivated enlistees from one year earlier who would have been college sophomores had they not instead joined the military. These can be estimated as follows:

$$\Delta S_t = (\Delta CJDM19_t + \Delta CDDM19_t) + (\Delta CJDM18_{t-1} + 0.375 \Delta CDDM18_{t-1}),^{11} \quad (3.2)$$

where

$$\Delta CJDM19_t = -CJDM19_t + 0.5\ CDDM19_{t-3} + 0.5\ CDDM19_{t-4}, \quad (3.2a)$$

$$\Delta CDDM19_t = -CDDM19_t + 0.5\ CDDM19_{t-3} + 0.5\ CDDM19_{t-4}, \quad (3.2b)$$

$CJDM19_t$ and $CDDM19_t$ are 19-year-old draft-motivated enlistees similar to $CJDM18_t$ and $CDDM18_t$, respectively.

ΔS_t = change in sophomore enrollment in year t,

and

$CJDM18_t$ and $CDDM18_t$ are defined in equation (3.1).

A draft has four effects on college junior enrollment: (1) individuals drafted out of college to serve in the military, (2) consci-

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11 Note that 100 percent of CJDM18 would have reached their sophomore year, but only 37.5 percent of CDDM18 would have reached their sophomore year in the absence of a draft. [As shown later in this section, it is assumed that the attrition rate from freshman to sophomore is 25 percent and from sophomore to junior is 20 percent, so that the cumulative attrition rate from freshman to junior is 40 percent; thus, only 37.5 percent of CDDM18 (i.e., 40 percent less 25 percent divided by 40 percent) would have made it to their sophomore year.]

entious objectors required to perform alternate service, (3) 19-year-old draft-motivated enlistees from one year earlier who would have been college juniors in the absence of a draft, and (4) 18-year-old draft-motivated enlistees from two years earlier who would have been college juniors in the absence of a draft. These effects can be estimated as follows:

$$\Delta J_t = \Delta CJI_t + \Delta CJCO_t + \Delta CJDM19_{t-1} + \Delta CJDM18_{t-2}, \quad (3.3)$$

$$\Delta CJI_t = -CJI_t + CJI_{t-2}, \quad (3.3a)$$

$$\Delta CJCO_t = -CJCO_t + CJCO_{t-2}, \quad (3.3b)$$

where

CJI_t = college junior draftees in year t,

$CJCO_t$ = college junior COs in year t,

ΔJ_t = change in junior enrollment in year t, and

$\Delta CJM18_t$ and $\Delta CJDM19_t$ are previously defined.

In addition to providing the basis for calculating the effect of a draft on junior-class enrollment, equation (3.3) shows that military manpower procurement policy not only has an immediate effect on junior-class enrollment but also will continue to affect junior enrollment for another six years.[12]

Assuming that there is a 10 percent attrition rate among college juniors, we can approximate the effects of a draft on total college enrollment as follows:

$$\Delta TE_t = \Delta F_t + \Delta S_t + \Delta J_t + 0.9\,\Delta J_{t-1} \quad (3.4)$$

where

ΔTE_t = change in total college enrollment in year t, and

ΔF_t, ΔS_t, and ΔJ_t are previously defined.

Assuming further that there is a 5 percent attrition rate among college seniors, the cumulative attrition rate for college juniors and seniors is about 14.5 percent. From equation (3.3), we can then estimate the effects on college graduates as follows:

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[12] That is, note that ΔJ_t is a function of $CJDM18_{t-2}$, which, in turn, is a function of $CJDM18_{t-6}$.

$$\Delta CG_t = 0.855\ \Delta J_{t-2} \qquad (3.5)$$

where ΔCG_t = change in college graduates in year t.

To the extent that the size of the officer corps is changed, the effects on civilian college graduates can be estimated as follows, assuming that officers serve four years:

$$\Delta CCG_t = \Delta CG_t + \Delta O_t, \qquad (3.6)$$

where

$$\Delta O_t = -O_t + O_{t-4}, \qquad (3.6a)$$

O_t = additional officers procured in year t,

ΔCCG = change in civilian college graduates, and

ΔCG_t is previously defined.

Thus, note from equations (3.3) and (3.5) that a change in military manpower procurement policy will not affect the total number of college graduates for two years, given the youngest-first draft policy. However, to the extent that a change in military manpower procurement policy is accompanied by a change in the number of new officers recruited, then equation (3.5) shows that there will be a corresponding immediate effect on the number of new college graduates available to the civilian sector.

To estimate the effects of a draft on the numbers of new S&E graduates available to the civilian sector, we make the following assumptions: (1) 11 out of every 23 male college graduates (47.8 percent) earn degrees in S&E fields; (2) 75 percent of additional officers procured have S&E degrees due to the more technical requirements of the military; and (3) only 25 percent of COs have degrees in S&E fields (i.e., assuming that more COs tend to be in the arts and humanities). We can estimate the change in civilian S&E graduates,

$$\Delta CSED_t = 0.478\ \Delta CG_t + 0.75\ \Delta O_t - 0.25\ \Delta CO_t. \qquad (3.7)$$

Finally, to estimate the effects on the numbers of S&E jobholders, assume that six out of every 11 male S&E graduates (54.5 percent) are employed in S&E jobs. Assume further that 50 percent enter such jobs immediately upon graduation, 20 percent one year later, and 10 percent each after two, three, and four years. Thus, the effects of changes in military manpower procurement on the number of civilian S&E jobholders can be given as follows:

$$\Delta CSEJ_t = 0.545\ (0.5\ \Delta CSED_t + 0.2\ \Delta CSED_{t-1} + 0.1\ \Delta CSED_{t-2} + 0.1\ \Delta CSED_{t-3} + 0.1\ \Delta\ CSED_{t-4}), \quad (3.8)$$

where

$\Delta CSEJ_t$ = change in civilian S&E job holders in year t,

and

$\Delta CSED_t$ is as defined in equation (3.6).

Together, then, equations (3.1) to (3.8) provide us with a simple model for estimating the effects of changes in military manpower procurement on the future supply of scientists and engineers.

Assumptions

In addition to the assumptions outlined previously in the discussion regarding the methodology, the analysis presented here is based on the following assumptions:

1. Population. It is well known that the youth population will decline significantly during the next fifteen years. The population projections under which the analysis here is conducted are presented in Tables A-1 and A-2 on pages 76 and 77.

2. Education flows. For consistency with the National Research Council's earlier efforts in this area, the results presented here are based on the education flows used by Wolfle in his paper prepared for the Council.[13] The specific assumptions are presented in Table 3-1. Using these assumptions and the population projections given in Tables A-1 and A-2, we can thus calculate the numbers of S&E graduates, etc., that would be produced in the absence of any military manpower procurement policy change. These estimates are also presented in Tables A-1 and A-2.

3. Military manpower supply. When an individual attempts to enlist or is drafted, he or she must meet certain mental, medical, and moral standards. Individuals are given a mental aptitude test and then classified into one of five categories, with Mental Category I representing the top seven percent of the population and Mental Category V legally ineligible for military service, representing the bottom 10 percent. Although Mental Category IV personnel (10th to 30th percent) are legally eligible for military service, the Services have historically limited the numbers of such personnel accessed. An estimate of the distribution of the male population according to mental category and other (medical and moral) qualifications is given in Table 3-2.

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[13] See Wolfle, op. cit.

TABLE 3-1: Future disposition of 18-year-olds (percent)

	Men	Women	Total
Reach age 18	100%	100%	100%
Finish High School	71	75	73
Enter College (Degree credit status)	45	40	42
Reach Junior Year*	27	24	25
Graduate from College	23	21	22
Earn S&E Degree	11	9	10
Enter S&E Occupation	6	3	5

*Estimated assuming 60 percent of those entering college reach their junior year.

Source: Dael Wolfle, "Potential Effects of Selective Service and of National Service on the Future Supply of Scientists and Engineers," paper prepared for the Commission on Human Resources of the National Research Council, March 1980.

TABLE 3-2: Distribution of 18-year-old males: Education and qualification for military service** (percent)

	College***	Non-College High School Graduate***	Non-High School Graduate***	Total
All	45.0	26.0	29.0	100.0
Mental Category I-III	29.0	14.0	7.6	50.6
Mental Category I-IV	31.0	17.4	14.3	62.7

** Shows the percentage of total 18-year-old population that falls into the particular cell. Thus, for example, 31 percent of all 18-year-old males are college bound and qualify for military service (as Mental Category I-IV); 17.4 percent are non-college bound high school graduates who similarly qualify; etc.

*** Distribution by college/non-college high school graduates was not available from the Defense Manpower Data Center data base. The estimates used here are the result of a subjective determination of what these distributions would likely be.

Source: 1971-1972 Pre-inductees examined by Armed Forces Examining and Entrance Station. Data furnished by Defense Manpower Data Center.

In addition to the above, we also need to project the supply of true volunteers. These projections, based on some of my earlier work,[14] are also given in Tables A-1 and A-2. (It should be noted that these are, of course, only estimates. Higher or lower unemployment, for example, would result in more or fewer true volunteers.)

4. Conscientious objectors. Estimates of the numbers of conscientious objectors in the event of a draft vary widely, from as many as 40 percent of those receiving draft notices to as few as 5 percent. The results presented in Section IV are based on the assumption that COs are equal to 20 percent of inductions (i.e., 16.7 percent of the induction notices issued), although the case of a much higher rate of COs is also examined.

5. Time. It is assumed that any change in manpower policy (i.e., the various "cases") will take place in 1982.

IV. RESULTS

Recognizing that we cannot forecast the future course of military manpower procurement policy, this section estimates the effects on the supply of scientists and engineers in a number of possible alternatives via the cases described in Section II. These cases serve both to illustrate the range of effects that could occur and to highlight the important policy variables.

This section is divided into three parts. The first focuses on how to measure the effects on S&E supply. The second provides estimates of these effects for the different cases outlined in Section II, assuming that changes in military manpower procurement policy do not affect an individual's ultimate behavior; these estimates are developed under the assumption that an individual who is drafted in his junior year, for instance, will return to college upon completion of his military duty. The last part of this section provides estimates of the effects on the supply of scientists and engineers, assuming that military manpower procurement policy does in fact change some aspects of individual behavior -- e.g., only three of every four juniors drafted return to college.

Measures

In order to evaluate the effects of military manpower procurement policy on the future supply of scientists and engineers, we need to first consider what measures to use. Three issues in particular deserve attention: (1) what outcome to measure, (2) whether to measure in yearly or cumulative terms, and (3) whether to express the results in absolute or percentage terms. Each of these issues is addressed below and is illustrated in the context of Case V.

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[14] See Cooper, op. cit., Chapter 9.

1. What to measure. A change in military manpower procurement policy will affect the entire S&E supply process. It will affect the number of young people going to college, involuntarily leaving college, returning to college, and, in general, enrolled in college. It will affect the number graduating from college, the number graduating and available for civilian employment, and the number graduating and available for employment in the scientific and engineering professions.

Recognizing that the ultimate concern of this paper is the supply of scientists and engineers, nevertheless useful is to first trace some of the effects on college enrollment -- that is, the input to the S&E supply process. Panel (a) of Figure 4-1 illustrates for Case V four different measures of the effects of military manpower policy on enrollment: (1) freshman enrollment (i.e., those going to college), (2) junior enrollment, (3) senior enrollment, and (4) total enrollment. The results in panel (a) show that the junior class would be the most immediately and most severely affected by the imposition of a draft. The reason, of course, is that the junior class is the one in the vulnerable age-group, both as draftees and as conscientious objectors. The effects on the senior class are the same as those on the junior class, except they are delayed by one year, since seniors at the time of a draft reinstatement would be beyond the vulnerable age-group.[15] Although the junior class (and a year later, the senior class) would be hardest hit, a draft would have a sizable impact on freshman and sophomore enrollment as well, given that some would-be freshmen and sophomores would likely join the military as draft-motivated volunteers. Indeed, perhaps the most striking feature of panel (a) of Figure 4-1 is not the differences in the curves displayed but, rather, the similarity in the magnitudes and timing of the effects for all levels of college enrollment. That is, even though the draft itself would be limited to one year of birth cohort, the presence of draft-motivated volunteers would serve to distribute the effects more evenly across total college enrollment.

Whereas panel (a) addresses the input to the S&E process, the focus of this paper is upon the output -- namely, the supply of scientists and engineers. In this regard, panel (b) of Figure 4-1 shows that a reinstatement of the draft would not affect the total number of college graduates produced for about two years. However, the number of college graduates available for civilian employment would be affected sooner to the extent that such a policy was accompanied by an increase in the size of the officer corps.

Perhaps most relevant for the purposes of this paper, however, is the number of civilian S&E graduates -- that is, civilian college graduates who earned their degrees in scientific or engineering disciplines. This represents the primary pool from which civilian employ-

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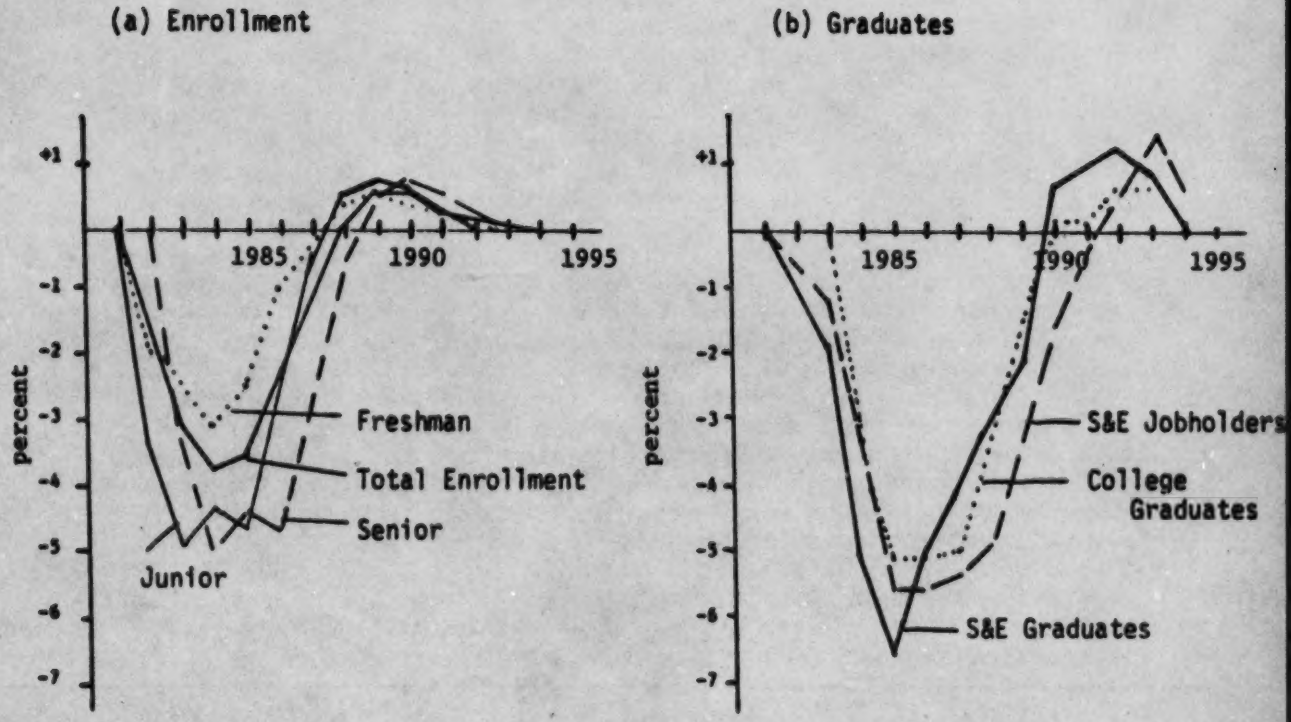
15 Even if the first year of the draft extended to all 20- to 26-year-olds, seniors would still be temporarily deferred, since present draft laws allow a senior to complete his final year of schooling.

FIGURE 4-1: Alternative measures of effects on S&E supply (Case V)



ers must recruit for S&E jobs. Panel (b) shows that the impact of a draft would be somewhat greater on S&E graduates than on college graduates in general. The reason for this is twofold. First, to the extent that a draft would be accompanied by an increase in the size of the officer corps, the technical nature of the military will likely result in the officer corps' drawing more than a proportional share of S&E graduates. Second, to the extent that a draft is limited to men, or at least draws more heavily on men, a draft would have a larger impact on S&E graduates than on college graduates as a whole, since a larger fraction of male college graduates earn their degrees in S&E fields than is the case for women.

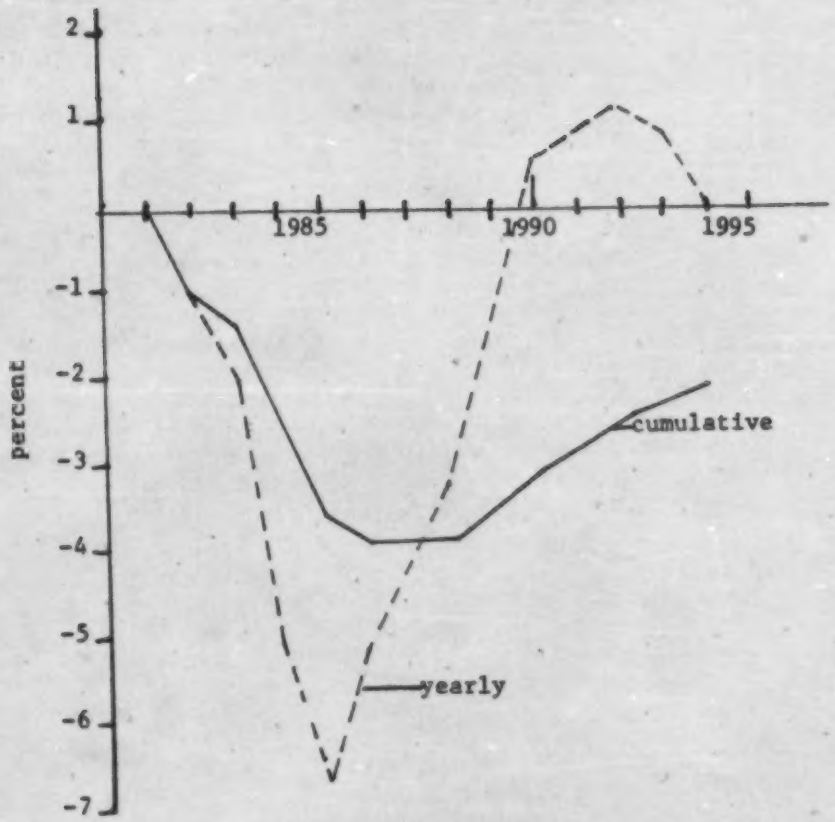
Also shown in panel (b) of Figure 4-1 is the effect on the number of S&E professionals, assuming that a given decrease in male S&E graduates results in a proportional decrease in male S&E jobholders. The results in panel (b) show that a draft would have a larger effect on this measure of S&E professionals than it would on S&E graduates, since Table 3-1 presented earlier showed a much smaller proportion of female S&E graduates entering S&E professions than is the case for males. Note also that the effect on S&E professionals lasts longer because, it is assumed, S&E graduates enter the job market over several years. This measure of S&E professionals, however, does not seem to be appropriate for reflecting the effects of a draft on the supply of scientists and engineers, since the number of S&E graduates entering S&E jobs today may be as much a result of the availability of such jobs as it is a measure of qualified applicants. Thus, assuming that a given decline in S&E graduates is translated into a proportional decline in S&E professionals probably overstates the effects of a draft on the supply of scientists and engineers.

The remainder of this paper will accordingly focus primarily upon the numbers of S&E graduates available to the civilian sector as the measure of military manpower-procurement effects on the future supply of scientists and engineers.

2. Year-by-year vs. cumulative. A draft delays by a few years the education -- and, hence, graduation -- of some college students. After these individuals have fulfilled their military obligation, they are available to enter or re-enter college, thus helping to offset the losses of future college and college-bound youth who enter the military. As a result, although the imposition of a draft would result in an immediate decline in the number of S&E graduates, that decline reverses itself after a few years as those initial draftees and draft-motivated volunteers return to civilian life. In fact, Figure 4-2 shows that, after about eight years, there would be a net increase in the number of S&E graduates relative to what would have been the case in the absence of a draft.

Although these year-by-year effects are useful for assessing the number of new entrants into the civilian S&E labor force each year, cumulative figures would seem to be a more useful measure for assessing, from a policy perspective, the aggregate impact over time resulting from changes in military manpower-procurement policy. As-

FIGURE 4-2: Alternative measures for Case V (yearly vs. cumulative)



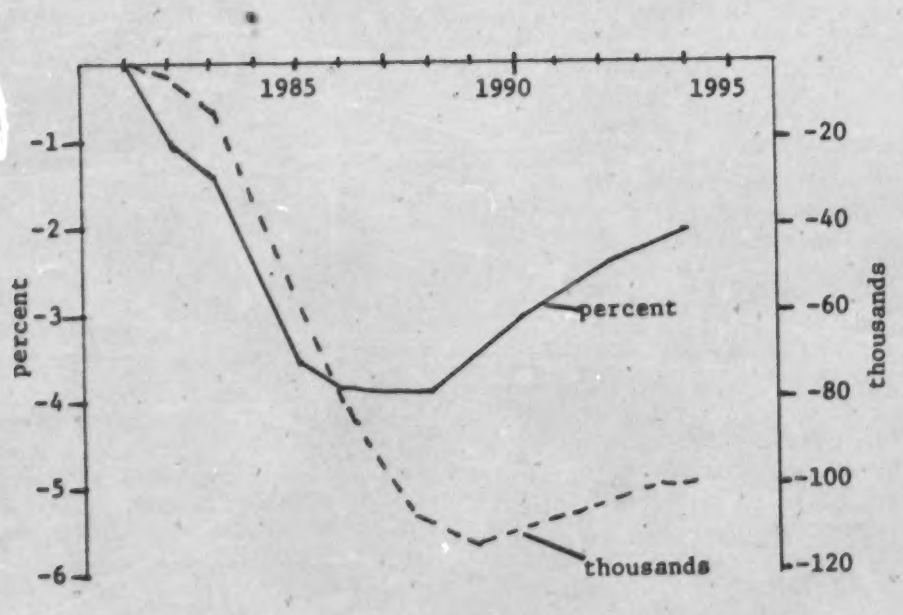
suming that manpower policy changes in 1982, we can calculate the cumulative net decrease or increase over time in the number of S&E graduates produced and compare that with the cumulative number that would have been produced in the absence of any military manpower procurement policy change. This measure thus reflects the net cumulative effect over time of a given change in manpower policy.

The comparison of the year-by-year and cumulative measures can be seen in Figure 4-2. These results show that the cumulative effect of a given change in manpower policy will peak about three to six years after the policy change (five years for Case V shown in Figure 4-2) and then lessen over time as individuals begin to return to college. However, unlike the year-by-year figures, which show that the return of these individuals to college eventually has a positive effect on the number of S&E graduates, the cumulative figures reveal that this later net increase is not enough to offset entirely the earlier net decrease. Thus, although the cumulative effect of a draft lessens over time, it still remains negative.

This paper will focus mainly on the cumulative effects of different potential manpower policies, under the rationale that the cumulative measure is more appropriate for assessing the aggregate impact over time of such policies.

3. Absolute numbers vs. percent. Finally, we considered whether to present the results in terms of aggregate numbers or percent (relative to the number of S&E graduates that would have been produced in the absence of any manpower policy change). Figure 4-3 shows that the numerical impact of Case V, for example, peaks in 1989, when there are about 110,000 fewer S&E graduates than there would have been had no policy change been effected. Percentage-wise, however, the peak is two years earlier. The reason for this is that the 95,000 fewer S&E graduates produced between 1982 and 1987 is a larger proportion of the 2.5 million that would have been produced in the absence of a draft than is the 110,000 fewer of the 3.2 million that would have been produced between 1982 and 1989. Figure 4-3 also shows that the percentage effect of Case V is lessened substantially over time, from a peak of 3.8 percent in 1987 to 2.0 percent in 1995, even though there is only modest change in the cumulative numbers of S&E graduates over this period. The reason for this, again, is that the cumulative numbers of S&E graduates produced over time swamps the decrease resulting from a given change in military manpower policy. For example, the 98,000 fewer S&E graduates produced between 1982 and 1995 as a result of Case V is only 2.0 percent of the 5.2 million that would have been produced had there been no change in manpower policy, whereas the 59,000 fewer produced between 1982 and 1985 is 3.5 percent of the 1.7 million that would have been produced during those four years. In other words, between 1985 and 1995, the cumulative effect of Case V is 40,000 fewer S&E graduates; but in those same 10 years 3.5 million new S&E graduates would be produced. Therefore, the percentage measure would seem to be the most appropriate, since it reflects the impact of different possible manpower policy changes relative to what would have been the case in the absence of such changes. The remainder of this

FIGURE 4-3: Alternative measures for Case V (percent vs. absolute numbers)



paper accordingly focuses primarily on the percentage, rather than the absolute, numbers.

Summary. Although the effects of changes in military manpower procurement policy can be described in a number of ways, this paper will focus mainly on (1) S&E graduates, as opposed to other outcomes; (2) the cumulative effects over time, as opposed to the yearly effects; and (3) percent relative to what would have been produced in the absence of any military manpower policy change, as opposed to absolute numbers.

Military Manpower Procurement Scenarios

We begin the analysis by assuming that military manpower procurement policy does not affect an individual's ultimate behavior pattern toward college attendance; it only alters the timing of his college attendance pattern. For example, an individual who would have graduated from college in the absence of the draft, but is instead drafted just prior to his junior year, is assumed to return to college as a junior upon the completion of his two-year period of service as a draftee. The following discussion analyzes the effects of military manpower procurement under the above assumption for the cases outlined in Section II.

1. 2.0-million-man force -- Cases I and II. As can be seen from Table 4-1, merely instituting the draft without further change in manpower policy (Case I) would do little to alter basic military manpower procurement. Indeed, even if a draft were initiated tomorrow, there would likely be few or no inductions until 1983. Thereafter, the need for inductions (and draft-motivated enlistments) would increase gradually throughout the 1980s because of the decline in the size of the male 18-year-old population. Even at its peak, though, fewer than 70,000 out of the 350,000 needed annually would come to the military via the draft or threat of the draft (i.e., draft-motivated volunteers). The reason for this is simply that present pay levels are sufficient or nearly sufficient to recruit the numbers of volunteers needed to man a 2.0-million-man armed force. The impact on would-be college juniors -- that is, those who would have made it at least as far as their junior year in the absence of a draft -- is even smaller. Columns (3) and (4) show that there would be very few draft-motivated enlistments from this group, and column (5) shows that there would be relative few draftees.

Should a reinstatement of the draft be accompanied by raised quality standards, a draft would have a larger and more immediate effect, as shown by Case II also presented in Table 4-1. Not only would there be a larger impact on the total numbers of draftees and draft-motivated enlistments needed, as shown in column (7), but there would be an even larger proportional effect on would-be college juniors. The reason for this, of course, is that, while there are currently enough true volunteers to staff the armed forces under present quality standards, raising these standards significantly as in Case II would

leave the Services short of their recruitment goals, requiring a greater use of the draft. (It should be noted again that present quality standards are about the same as they have been historically, both with and without the draft. Case II, though clearly a possible policy option, nonetheless assumes much higher entrance standards than have ever been used to screen potential enlistees and inductees).

TABLE 4-1: Draft-motivated enlistments, inductions, and conscientious objectors for would-be college juniors: 2.0-million-man forces, Cases I and II (in thousands)

		CASE I					CASE II				
		Total	Would-Be Juniors				Total	Would-Be Juniors			
Year	Off	I&DM	DM18	DM19	I	CO	I&DM	DM18	DM19	I	CO
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
1982	0	0	0	0	0	0	54	5	2	11	2
1983	0	14	1	1	2	1	61	6	3	13	3
1984	0	30	2	1	5	1	66	6	3	14	3
1985	0	38	2	1	7	1	71	7	3	15	3
1986	0	42	3	1	7	1	73	7	3	16	3
1987	0	48	3	1	8	2	77	7	4	17	3
1988	0	54	3	2	8	2	80	7	4	18	4
1989	0	60	4	2	10	2	84	8	4	18	4
1990	0	66	4	2	10	2	85	8	4	18	4
1991	0	68	4	2	10	2	86	8	4	18	4
1992	0	68	4	2	10	2	86	8	4	18	4
1993	0	68	4	2	10	2	86	8	4	18	4
1994	0	66	4	2	10	2	85	8	4	18	4

Legend

Total I&DM: Total inductions and draft-motivated enlistments
DM18: 18-year-old draft-motivated enlistments for would-be juniors (CJDM18 in equation 3.1a)
DM19: 19-year-old draft-motivated enlistments for would-be juniors (CJDM19 in equation 3.2a)
I: Inductions from would-be juniors (CJI in equation 3.3a)
CO: Conscientious objectors from would-be juniors (CJCO in equation 3.3b)
Off: Additional officers (O in equation 3.6a)

Perhaps the most striking result to emerge from Figure 4-4, which shows the cumulative impact of these two cases upon the future supply of scientists and engineers, is that the reinstitution of a draft will have a relatively small effect so long as force sizes are maintained at or near their present levels. Even if quality standards are raised higher than they have ever been, there would be a one percent decrease in the cumulative number of scientific and engineering degrees granted. Should quality standards not be raised, Case I in Figure 4-4 shows the effect to be 0.5 percent or less.

FIGURE 4-4: Cumulative S&E degrees for 2.0-million-man draft (Cases I and II)

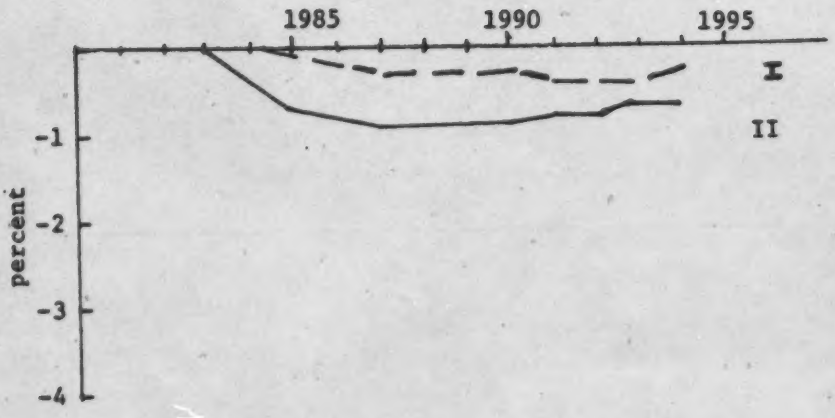


TABLE 4-2: Draft-motivated enlistments, inductions, and conscientious objectors for would-be college juniors: 2.5-million-man forces, Cases III-VI (in thousands)

Year	Off (all cases) (1)	CASE III Total DM&I (2)	CASE III Would-Be Juniors DMI8 (3)	DMI9 (4)	I (5)	CO (6)	CASE IV Total DM&I (7)	CASE IV Would-Be Juniors DMI8 (8)	DMI9 (9)	I (10)	CO (11)
1982	5	148	9	5	23	5	167	17	9	39	8
1983	10	164	10	5	26	5	177	18	10	42	8
1984	10	205	13	7	30	6	201	21	11	51	10
1985	10	238	15	8	40	8	206	21	11	53	11
1986	8	217	14	7	37	7	193	21	11	49	10
1987	8	198	12	7	34	7	182	19	10	46	9
1988	8	194	12	6	34	7	170	18	9	43	9
1989	8	190	12	6	33	7	174	18	10	44	9
1990	6	191	12	6	33	7	177	18	10	45	9
1991	6	192	12	6	33	7	178	18	10	45	9
1992	6	192	12	6	33	7	178	18	10	45	9
1993	6	192	12	6	33	7	178	18	10	45	9
1994	6	192	12	6	33	7	178	18	10	45	9

Year	CASE V Total DM&I (12)	CASE V Would-Be Juniors DMI8 (13)	DMI9 (14)	I (15)	CO (16)	CASE VI Total DM&I (17)	CASE VI Would-Be Juniors DMI8 (18)	DMI9 (19)	I (20)	CO (21)
1982	183	11	7	28	6	183	18	10	37	7
1983	231	13	7	36	7	231	22	12	46	9
1984	301	16	9	49	10	301	28	15	61	12
1985	332	18	10	54	11	332	31	16	65	13
1986	310	17	9	57	11	310	27	15	59	12
1987	289	16	9	53	11	289	29	14	56	11
1988	283	15	8	52	10	283	26	14	54	11
1989	277	15	8	51	10	277	26	14	54	11
1990	272	15	8	50	10	272	25	13	54	11
1991	273	15	8	50	10	273	25	13	54	11
1992	273	15	8	50	10	273	25	13	54	11
1993	273	15	8	50	10	273	25	13	54	11
1994	273	15	8	50	10	273	25	13	54	11

Legend: See Table 4-1.

2. 2.5-million-man force -- Cases III-VI. In the event that defense policy is revised to require a 2.5-million-man armed force, Table 4-2 shows that conscription would have a much greater impact on American youth. The reason for this, in general terms, is twofold. First, larger force sizes require larger numbers of new recruits and/or inductees in the steady state. Second, building from the pres-

ent 2-million-member armed force to a 2.5-million-member armed force initially requires even larger numbers of new recruits than are needed in the steady state. Thus, column (2) shows that the need for draftees and/or draft-motivated enlistees peaks in 1985 as the force build-up is completed and then gradually subsides during the following years, but it remains at a level much higher than that required of the 2-million-man force.

In addition to showing the importance of force sizes, Table 4-2 reveals the importance of other manpower policies when evaluating the effects of conscription. For example, coupling increased force sizes with raised quality standards (Case IV) would mean an even greater impact on college youth than would be the case should no other manpower policies be changed in the move to a larger force (Case III). Thus, even though the aggregate effect of Case IV for all military-aged youth is less than for Case III -- since the raised quality standards would likely result in reduced enlisted attrition rates (and, hence, reduced accession requirements) -- Case IV would have a considerably larger effect on college youth than would Case III.

A comparison of Case IV (raised quality standards) with Case V (reduced pay) indicates that these two very different policies have similar effects on college youth in the long run, although the effect of reduced pay is larger for all American youth than is that of raised quality standards. In the short run, however, the impact of the raised quality standards on college youth is actually greater since, it was assumed, this was a policy that could be implemented immediately, as opposed to the gradual reduction of pay assumed for Case V.

Finally, combining reduced pay with virtual elimination of so-called draft loopholes (Case VI) would lead to an even greater impact on college youth. Not only would the aggregate number of inductions and draft-motivated enlistments be nearly 50 percent greater for Case VI than for Case III, but the number of college and college-bound inductions and draft motivated enlistments would be nearly twice as much. (It will be shown later, though, that even if draft-loopholes are eliminated, college youth will bear less than their "fair share" of the burden, due to the fact that the draft itself comprises such a small part of total military manpower procurement).

The effects of these possible policy alternatives on the future supply of scientists and engineers can be found in Figure 4-5. All four cases have the same effect for the first two years because all four cases rely on the same assumptions regarding the size of a build-up in the officer corps. Since drafting for the enlisted forces does not have an effect on the supply of S&E graduates for two years, not until 1984 will any differences appear among the four cases illustrated. Once these differences appear, however, they become substantial. For example, Case VI results in a cumulative decrease of nearly 5 percent of S&E graduates by 1987, whereas Case III shows less than a 3 percent decrease. The importance of this information is not to pinpoint the exact effects on the future supply of scientists and engineers but, rather, to illustrate the importance of perhaps seemingly

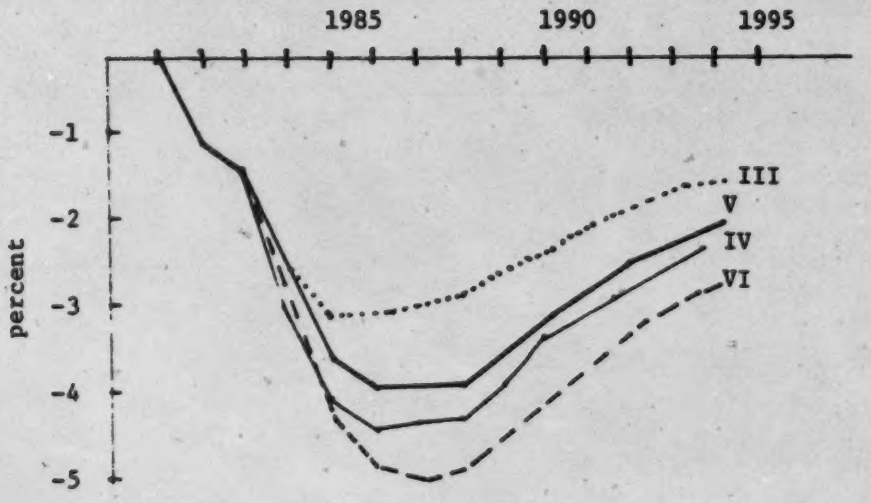
unimportant military manpower policy variables such as pay, draft deferments, and exemptions. Thus, Case VI, which assumes that military pay is reduced and that draft loopholes are all but eliminated, has a much larger effect on the future supply of scientists and engineers than, say, Case III, which only assumes that force sizes are increased.

In terms of some of the particulars, Figure 4-5 shows that Case IV (raised quality standards) and Case V (reduced pay) have similar effects on the future supply of scientists and engineers. Case IV has a greater effect on S&E graduates than does Case III, since (1) the size of the manpower pool eligible for military service has been reduced (because of the higher quality standards) and (2) college youth presumably make up a larger fraction of that pool. Thus, college youth make up a larger fraction of inductions and draft-motivated enlistments under Case IV than they do under Case III. Case V has a greater impact on S&E graduates than does Case III for a different reason. By reducing military pay, there will be fewer true volunteers so that the military will have to place greater reliance on inductions and draft-motivated enlistments, which, in turn, will increase the numbers of college youth that serve. Thus, in contrast to Case IV, where college youth make up a large proportion (relative to Case III) of a given number of inductions and draft-motivated enlistments, Case V results in larger numbers of college youth serving (again, relative to Case III) because they make up about the same proportion of a larger number of inductions and draft-motivated enlistments.

As shown in Figure 4-5, Case IV (higher quality standards) actually has somewhat greater impact on S&E graduates than Case V (reduced pay), although the effects are similar in magnitude. The reason for this, as noted earlier, is that Case IV assumes that higher quality standards would be implemented immediately, whereas Case V assumes that pay would be reduced gradually over the first three years of the draft. Had Case V assumed that the full pay-cut had been implemented immediately, then the two curves in Figure 4-5 would have been nearly identical.

Finally, we note the dynamics of the effects that the four cases in Figure 4-5 have on the supply of S&E graduates. In particular, the effects of a draft on the future supply of S&E graduates peak after three to six years, as the force buildup is completed, and then gradually lessen over time as those initially drawn into the military return to college. To illustrate, Case VI results in the production of about 5 percent fewer S&E graduates between 1982 and 1987 than would have been the case in the absence of a draft. Because the rate of decrease in S&E graduates brought about by the draft is less after 1987 than is the rate of increase in total numbers of new S&E graduates produced -- indeed, for some years, returnees outnumber those drawn into the military -- the cumulative effect of the draft lessens. Because of this, Case IV, for instance, results in only 2.8 percent fewer S&E graduates produced between 1982 and 1994 than would have been the case without the draft.

FIGURE 4-5: Cumulative S&E degrees for 2.5-million-man draft (Cases III, IV, V, and VI)

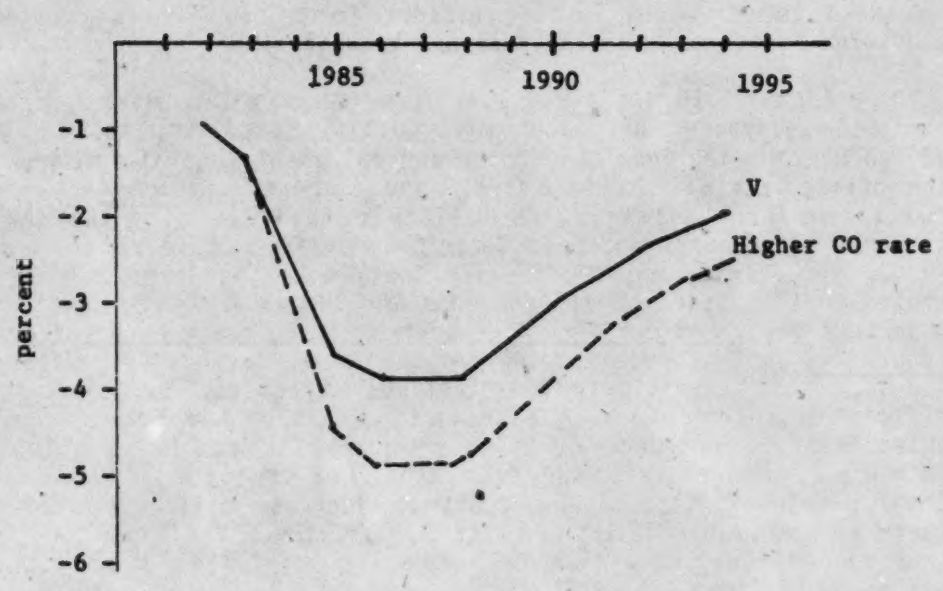


Not only are the effects of a draft on the supply of S&E graduates a function of such policy variables as pay and quality standards, they are also importantly a function of the numbers of conscientious objectors serving in alternate-service programs. In this regard, the estimates developed thus far have been based on the following assumptions: (1) COs serving in alternate-service programs equal 20 percent of the number of inductions, and (2) a smaller proportion of CO college graduates would be in S&E fields than would be the case for inductions (25 percent for COs versus 48 percent for inductions).

To illustrate the importance of these assumptions, consider the following alternative. First, suppose that 40 percent of those re- ceiving induction notices file and qualify for CO status. (Brian Pepitone, former Director of the Selective Service System, has estimated that CO rates could in fact run this high.) And second, suppose that the percentage of COs who would earn degrees in S&E fields is the same as for inductions in general (48 percent). The effects of these assumptions on future supply of S&E graduates are clearly substantial, as Figure 4-6 illustrates for Case V. Indeed, the reduction of S&E graduates is about one-third greater under these assumptions than under the assumptions originally used for Case V.

Whereas the preceeding discussion, as with most discussions about military manpower procurement, has focused mainly on the effects associated with enlisted procurement, we need also to recognize the importance of officer procurement. Numerically, different military manpower procurement scenarios will have a far smaller effect on the numbers of officers procured as opposed to the numbers of enlisted personnel procured -- hence, the historic focus on the enlisted forces. For three reasons, however, changes in officer procurement will have a larger proportional effect on the future supply of scientists and engineers than will changes in enlisted procurement. First, changes in officer procurement have an immediate effect on S&E supply, since those individuals procured for the officers corps are already college graduates. By way of contrast, would-be college and college-bound enlisted members would not, in the absence of a draft, be college graduates for several years. Second, for every additional individual recruited into the officer corps, there is one fewer college graduate available for the civilian sector. Again, in contrast, every would-be college junior inducted results in the loss of 0.855 college graduates, since only about 85.5 percent of college juniors in fact graduate from college; and every would-be college freshman enticed to serve as a draft-motivated volunteer results in the loss of about 0.52 college graduates. Third, because of the more technical nature of the military, we assumed that 75 percent of any additional officers procured would have an S&E degree, whereas only about 48 percent of would-be college graduates who serve in the enlisted ranks would likely have S&E degrees (i.e., the same proportion as for male college graduates as a whole). The end result is as follows: for every additional officer procured, there is a reduction of 0.75 S&E graduates, immediately; for every would-be college junior inducted into the military, there is a reduction of 0.40 S&E graduates, two years later; and for

FIGURE 4-6: Effect of different CO assumptions on cumulative S&E degrees for Case V



every would-be college freshman serving as a draft-motivated volunteer, there is a reduction of 0.25 S&E graduates, four years later.

The effects of different assumptions regarding the size and rapidity of a buildup in the officer corps for the future supply of scientists and engineers can be found in Figure 4-7, which again illustrates these results in the context of Case V (2.5-million-man draft with reduced military pay). Although the effects of the three different sets of assumptions are very similar in the long run, they differ substantially in the short run. For example, by 1985 the smaller, slower buildup in the officer corps results in about 2.5 percent fewer (cumulative) S&E graduates available than there would have been in the absence of draft, whereas the larger, more rapid buildup results in about 4.2 percent fewer. In other words, the cumulative effect of the larger, more rapid buildup is nearly 70 percent greater than for the smaller, slower buildup through 1985. These differences lessen over time, however, as the effects brought about by the much larger numbers of enlisted accessions begin to dominate those brought about by changes in the size of the officer corps. Nevertheless, the results presented in Figure 4-7 show that relatively minor differences in the rate of growth in the officer force can have a substantial short-run impact on the supply of S&E graduates.

Finally, Figure 4-8 illustrates the combined effects of these various assumptions (1) about pay, quality standards, and so forth; (2) about conscientious objectors; and (3) about the rate of growth in the officer corps. To demonstrate the extremes, Figure 4-8 presents two cases, III* and VI*. Case III* is Case III with the smaller, slower officer-corps increase described earlier. Case VI* is case VI (i.e., reduced pay and draft exemptions) with the larger, more rapid growth in the officer corps and with the higher rate of conscientious objectors described earlier. The most striking feature to emerge from Figure 4-8 is that such seemingly second-order factors as military pay levels, draft exemptions, conscientious objectors, and size of the officer corps can have such a dramatic effect on the future supply of scientists and engineers. In this regard, it should be noted that both cases shown are drawn from the same broad policy context -- namely, reinstitution of the draft to increase military forces from their present 2.0 million level to 2.5 million. Yet Figure 4-8 shows that Case VI* has more than twice the impact on the future supply of S&E graduates than Case III* has.

3. 3-million-man force -- Cases VII-IX. In the event that defense policy is revised substantially so as to require much larger forces than is presently the case, there will be a correspondingly larger impact on the future supply of scientists and engineers. Three cases here are used to illustrate these effects. Case VII assumes a gradual but substantial five- to six-year buildup in force sizes to 3.0 million members and the same reduction in military pay as assumed for Case V. Case VIII is the same as Case VII, except that Case VIII assumes that during the first year of the draft, all 20- to 22-year-olds would be equally vulnerable to conscription; thereafter, the draft would revert to the youngest-first policy assumed for Case VII. Case

FIGURE 4-7: Cumulative S&E degrees for Case V under different assumptions about numbers of officers

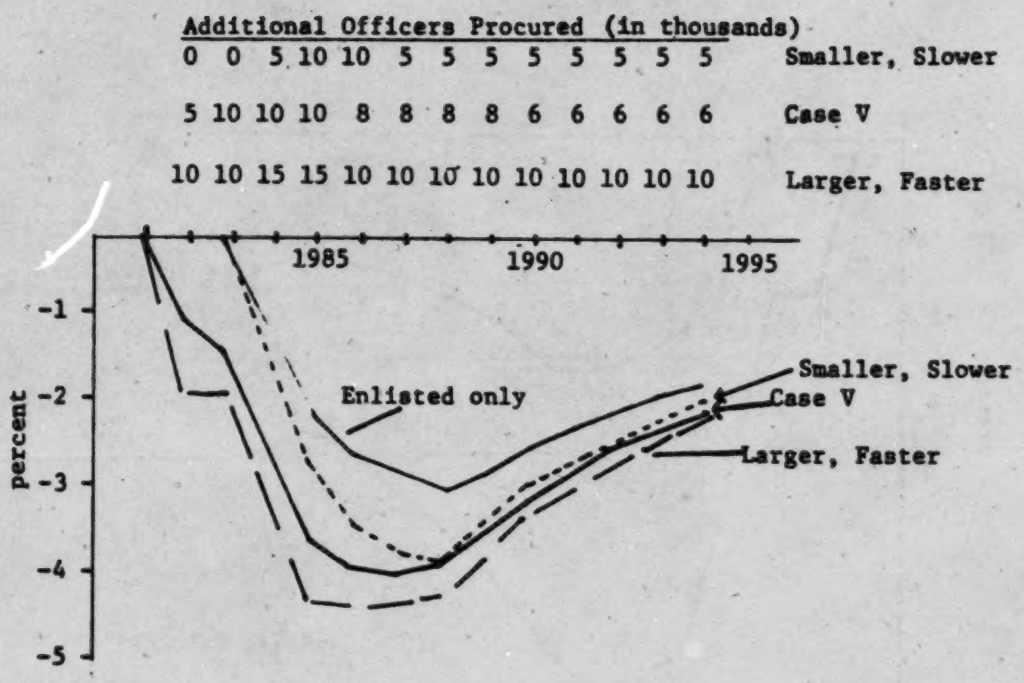
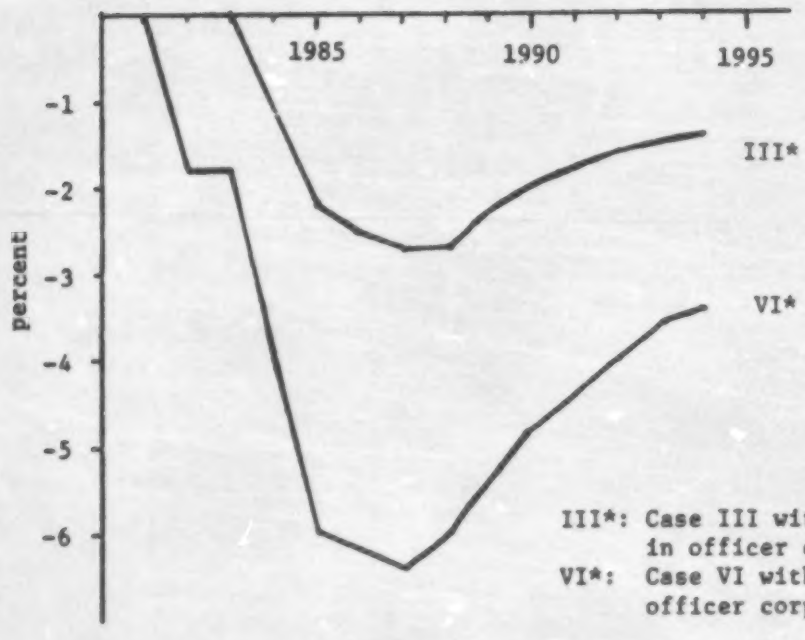


FIGURE 4-8: Cumulative S&E degrees for 2.5-million-man draft: Effect of military manpower policy, conscientious objectors, and officer force



III*: Case III with smaller buildup in officer corps
VI*: Case VI with larger buildup in officer corps plus more COs

IX is the equivalent of full mobilization, whereby military forces are increased to about 3.5 million members within two years and then are gradually reduced to 3 million members or so over the next eight years. The effects of these scenarios for the incremental numbers of officers needed for the total numbers of inductions and draft-motivated enlistments from would-be college juniors are shown in Table 4-3, which shows clearly that these scenarios would have a much larger impact on youth in general and on college youth than would the smaller force sizes discussed previously.

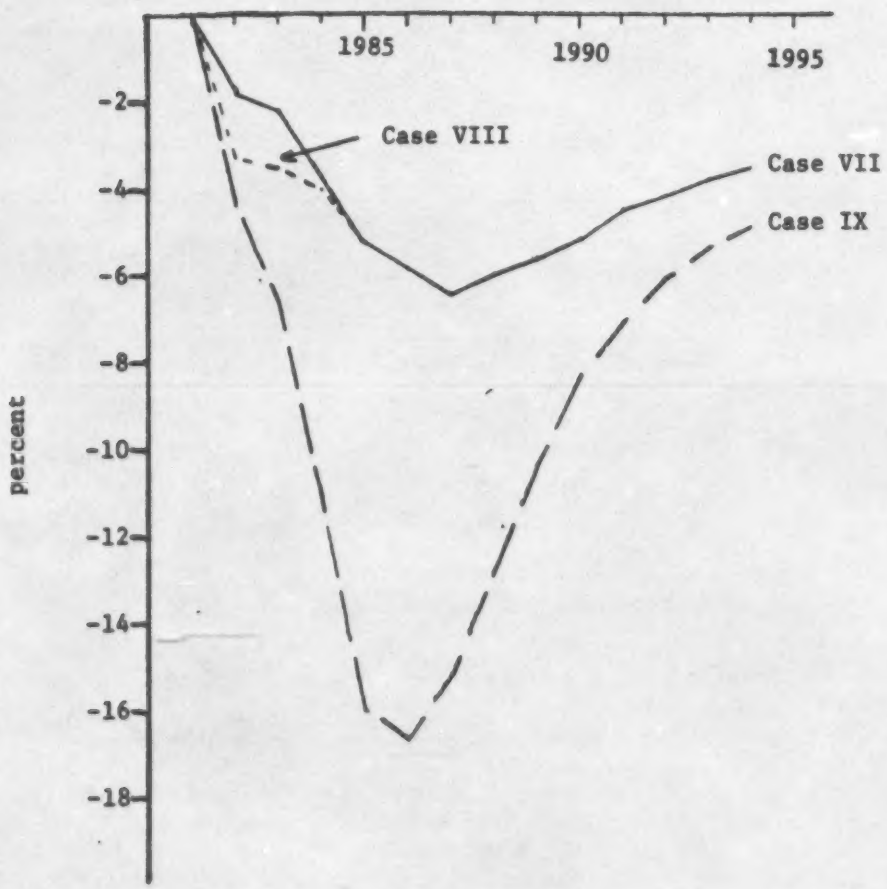
TABLE 4-3: Draft-motivated enlistments, inductions, and conscientious objectors for would-be college juniors: 3.0-million-man forces, Cases VII-IX (in thousands)

	CASES VII and VIII						CASE IX					
		Total	Would-Be Juniors					Total	Would-Be Juniors			
Year	Off	I&DM	DM18	DM19	I	CO	Off	I&DM	DM18	DM19	I	CO
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1982	10	183	11	6	28	6	25	683	56	29	106	21
1983	15	283	16	9	45	9	50	931	73	44	173	35
1984	20	476	26	15	78	16	50	776	58	37	168	34
1985	20	482	26	15	80	16	50	682	51	30	149	30
1986	20	485	26	15	81	16	40	585	44	26	116	23
1987	20	489	26	15	82	16	40	489	37	21	97	19
1988	15	468	25	15	79	16	30	468	35	20	93	19
1989	15	447	24	14	75	15	30	447	33	20	89	18
1990	15	452	24	14	76	15	30	452	34	20	90	18
1991	15	453	24	14	76	15	25	453	34	20	90	18
1992	15	453	24	14	76	15	25	453	34	20	90	18
1993	15	453	24	14	76	15	25	453	34	20	90	18
1994	15	452	24	14	76	15	20	452	34	20	90	18

Legend: See Table 4-1.

The translation of this information into the effects on the future supply of S&E graduates is presented in Figure 4-9. As expected, these scenarios have a much more pronounced effect on future supply of S&E graduates than did the earlier cases considered. Case VII (a 3-million-man force with reduced pay) reaches its maximum effect after about six years, when there are about 5.4 percent fewer S&E graduates than would have been the case had present policy been continued. Note that Case VII is identical to Case VIII in the long run, but opening up the first year of the draft to more than just one age-group obviously results in a more immediate impact on S&E graduates. That is, recent college graduates would be subject to the draft as well as college juniors. College seniors, in the first year of the draft, would be temporarily deferred until the completion of their senior year, but those selected in the first-year draft lottery would have to serve immediately upon graduation.

FIGURE 4-9: Cumulative S&E degrees for a large-scale draft (Cases VII-IX)



A full mobilization would have an even larger effect. After about five years, there would be nearly 17 percent fewer S&E graduates than would have been the case had present policy continued. Although this is clearly a significant impact, perhaps the most surprising result is that the mobilization scenario does not have a larger effect on S&E graduates. One reason for this is simply that the birth cohorts that would be subject to the draft are large enough to absorb a major buildup in military manpower strengths without having a devastating effect on the numbers of college graduates produced. Unlike the Korean War buildup, where the number of male 18-year-olds ran only somewhat above 1 million yearly, today's 18-year-old male birth cohorts are in the neighborhood of 2 million a year. Although this number will fall in the years ahead, there will still be significantly more 18-year-olds than, say, in the early 1950s.

4. National Service -- Case X. Finally, consider a national-service type of draft, such as that put forth by Rep. McCloskey of California. Under the McCloskey scheme, each 18-year-old would be required to register for one of the following four options, although options (a) and (c) could be postponed for a few years if the individual so chose:

a. Military service: Two years of military service at a subsistence wage (say $200 per month). At the end of the two years, the individual would be eligible for four years of educational benefits, such as those provided by the post-World War II GI Bill.

b. Reserve service: Six months active military service to be followed by 5-1/2 years of reserve duty.

c. Civilian service: One year of civilian service at a subsistence wage. Although the McCloskey Bill would provide no educational benefits for this option, some have argued that these individuals ought also to be eligible for some educational benefits.

d. None of the above: Those 18-year-olds who chose not to sign up for any of the above options would enter a draft pool, where for six years, until age 24, they would be liable for induction in the event that not enough volunteers were forthcoming to meet military needs.

Put differently, the McCloskey bill would result in the reinstatement of the selective-service draft. However, an individual could exempt himself from the draft by "volunteering" for (a) active military service, (b) service in the reserves, or (c) a one-year tour in civilian service.

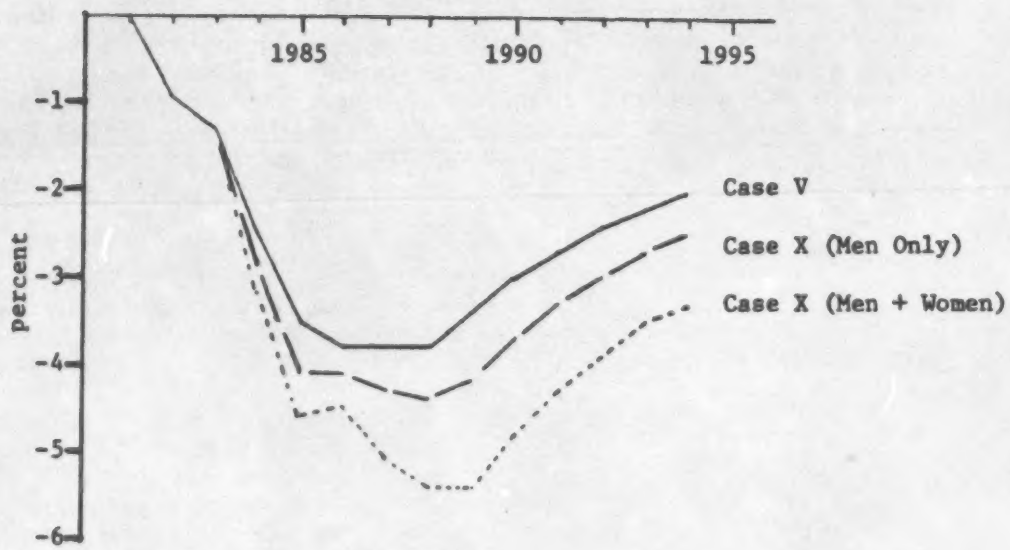
To illustrate the effects of a national-service draft on the future supply of scientists and engineers, we will consider the following variation of the McCloskey-type bill. To begin, we will assume that Case V prevails for the military portion of the program -- that is, a 2.5-million-man force with reduced military pay. As with the

McCloskey plan, we will assume that the individual must register for one of four options upon reaching his 18th birthday: (a) military enlistment for three or four years (not the two years in the McCloskey plan, but the three- or four-year tour consistent with previous draft policy); (b) service in the reserves; (c) one year of civilian service; or (d) none of the above. (During the first year of the program, all 18- to 20-year-olds would be required to register.) Unlike the McCloskey bill, where the individual selecting option (d) would be liable for the draft for six years, we will assume that he has the same one-year period of prime vulnerability that was earlier assumed for Case V (and that is consistent with the draft reforms of the late 1960s).

Regarding the size of the civilian-service program, we will assume that the program is structured such that 25,000 would-be male college juniors serve the first year, 50,000 the second, 75,000 the third, and 100,000 per year thereafter. Since would-be college juniors constitute about one quarter of the male population, this program is roughly equivalent to a civilian service of about 100,000 males the first year, 200,000 the second, 300,000 the third, and 400,000 per year thereafter. The discussion here will further consider two variations of the program: male only and both sexes. In the latter case -- i.e., both men and women -- we will assume that the program size is simply doubled; in other words, a men-and-women national-service draft would not result in women replacing men but, rather, in their serving in addition to men. Finally, because one year of civilian service is likely to be a less onerous way for at least some would-be college juniors to avoid the draft than serving three or four years as a draft-motivated enlistee, we will assume that half the would-be college juniors who join the military as draft-motivated enlistees under Case V will instead opt for the one year of civilian service under this program.

The implications of this program for the future supply of S&E graduates can be found in Figure 4-10. Clearly, there the most striking feature is the relatively small effect that such a national-service program would have on future supply of scientists and engineers. That is, despite the relatively large numbers of individuals who would presumably be involved in this program, Case X has only a modest effect relative to Case V. (Remember, Case X is simply Case V plus the civilian service portion of national service.) For example, Case V would result in a 3.8 percent decrease in the cumulative number of S&E degrees produced between 1982 and 1986; the men-only version of Case X would result in only a 0.3 percent additional decrease, or 4.1 percent total decrease. Even if women were also included, the cumulative number of S&E degrees produced between 1982 and 1986 would be only 0.7 percent more for Case X than would have been the case under Case V. The reason for this relatively modest effect of national service is twofold. First, although a significant number of would-be college graduates are presumed to serve, they serve for a very short period, only one year. Thus, as 18-year-olds are entering national service, 19-year-olds are returning from national service to enter college. Second, to the extent that Case V draft-motivated volunteers

FIGURE 4-10: Cumulative S&E degrees for national service (Case X)



enter civilian service instead, Case X results in a net increase in the availability of S&E graduates, since three- and four-year draft-motivated volunteers are replaced by one-year civilian-service "volunteers."

Behavioral Effects

Whereas the analysis to this point has been based on the assumption that an individual's ultimate college-going behavior remains unaltered by the presence of a draft, it is important to consider the possible consequences if, in addition to altering the timing of an individual's college attendance, a draft were also to affect his ultimate college-going behavior. As noted in Section II, military manpower procurement policy could have several potential effects in this regard. For example, we might expect those otherwise college-bound youth to return to college in smaller numbers than would be the case in the absence of a draft, since the opportunity cost of going to college is likely to increase as the individual gets older. If, however, the reinstatement of a draft were accompanied by a reinstatement of the GI Bill, we might, in fact, see the reverse -- i.e., larger numbers returning to college than would have been the case in the absence of conscription. To illustrate the possible effects that such changes in behavior could have on the future supply of scientists and engineers, the discussion below will address two kinds of scenarios. Under the first, suppose that the imposition of a draft alters an individual's college-going behavior. Under the second, suppose that the AVF is retained but that present policy toward educational benefits is altered.

1. Behavioral effects under a draft. To understand the possible implications of changes in behavior, the discussion below will consider the following three variations on Case V (a 2.5-million-man draft with reduced pay):

Case V(a) -- reduced college participation -- assumes that college participation rates are reduced by 25 percent for would-be college juniors.

Case V(b) -- increased college participation -- assumes that the GI Bill is reinstated and that this results in 25 percent of would-be college dropouts reaching their junior year, at which time they exhibit the same graduation rates as other college juniors. In addition, this case assumes that this reinstatement will lead 10 percent of the otherwise non-college-bound high-school graduates serving in the military to enter college upon the completion of their military service.

Case V(c) -- increased S&E graduates -- assumes that college participation rates remain unchanged by the draft and that the more technical nature of military service causes 72 percent of those who serve to enter S&E fields (i.e., 1.5 times the 48 percent who would in the absence of military service).

The effects of these three cases, which can be found in Figure 4-11, show that while these different sets of assumptions have little or no impact in the short run, the long-run consequences are quite substantial. Case V(a) results not only in a one-time reduction in the availability of S&E graduates, as happens with Case V, but also a continued drain on the number of S&E graduates each year. In other words, we have the obvious result that a draft-induced reduction in college participation rates will have long-term negative consequences for the number of S&E graduates produced each year. Case V(b), increased college participation, obviously has the reverse effect. Not only do those who would have gone to college anyway return upon the completion of their military service, but also additional students are pumped in each year. Again, the short-run effects are minimal -- in fact, there is no effect for six years -- but in the long run, the numbers of young men who enter college via the military is larger than the number that are siphoned off initially. Indeed, although not shown in Figure 4-8, Case V(b) eventually results in a cumulative increase in the numbers of S&E graduates produced. Finally, although the exact relationship between Case V(b) and Case V(c) will of course vary according to the specific assumptions adopted, it is interesting to note that Case V(c) has both a more immediate and larger positive effect on the future supply of S&E graduates than does Case V(b). Thus, to the extent that military service increases the proportion entering S&E fields, as in Case V(c), the reinstatement of a draft could actually have a long-run positive effect on the numbers of S&E graduates produced and available for civilian employment.[16]

2. Behavioral effects under the AVF. Finally, consider the case where the availability of higher-education grants and loans would be tied to the performance of some military and/or civilian service, as put forth by some. Note that this would not be a national-service type of draft, since no one would be required to serve but, rather, would be a program that would require some form of military or civilian service if the individual was to be eligible for educational assistance.

To estimate the possible impact of such a policy, suppose that it reduces the numbers of men and women attending college initially by 5 percent, of which half go into the military to receive their educational benefits and half forgo college altogether. This is shown as Case XI(a) in Figure 4-12. Next, suppose that this policy is combined with a substantial improvement in military educational benefits, such that 25 percent of those high school graduates entering the military --

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[16] In this regard, a recent survey of Vietnam-era veterans reveals that about 8 percent of veterans received degrees in engineering, as opposed to the 5-7 percent of non-veterans during that period. Thus, although not a large difference (and possibly not statistically significant, given the sampling problems with the Veterans Administration survey), this finding is at least consistent with the above proposition. See "Completion Rates for Education and Training Under the Vietnam-Era GI Bill," Veterans Administration, June, 1976.

FIGURE 4-11: Cumulative S&E degrees for Case V, alternative behavioral assumptions

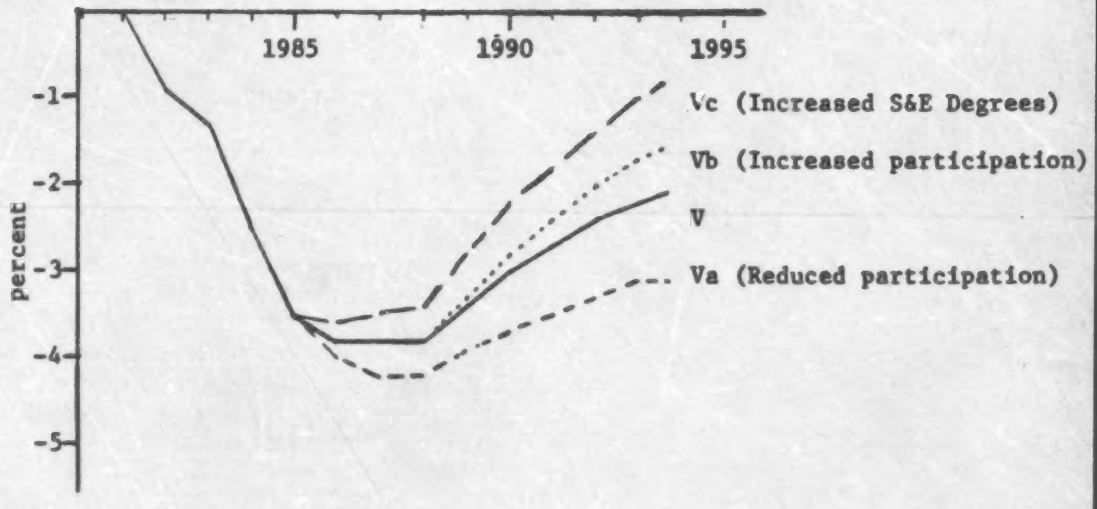
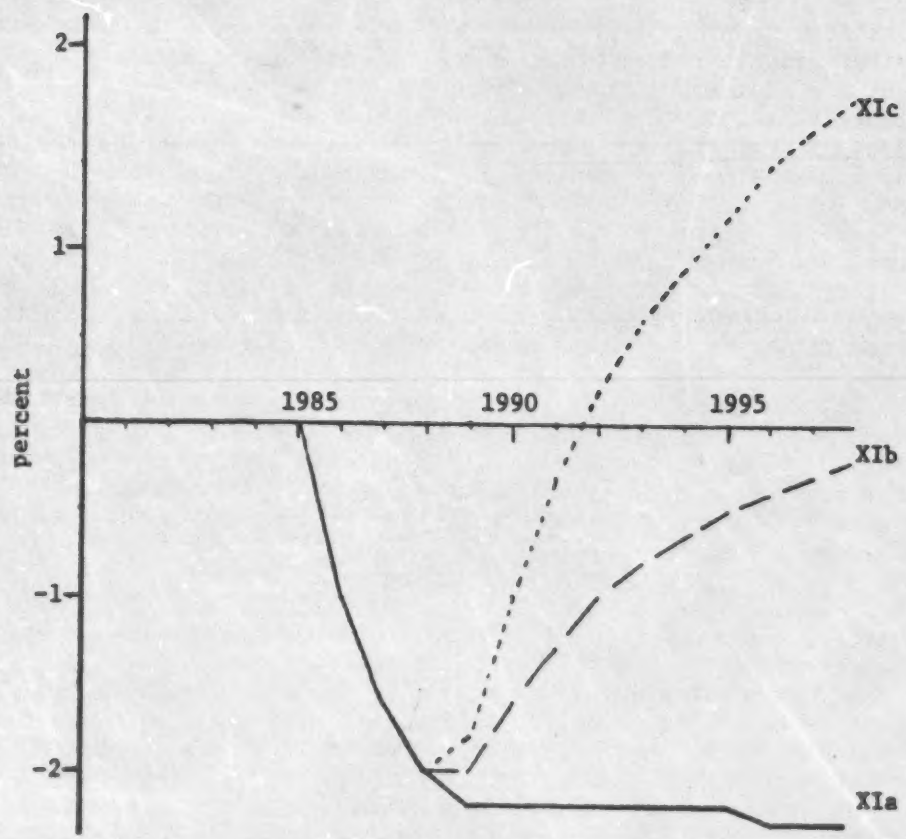


FIGURE 4-12: Cumulative S&E degrees as a function of educational benefits under the AVF (Case XI)



who would not have gone to college in the absence of such benefits -- in fact enter college. This is shown as Case XI(b) in Figure 4-12. Case XI(c) is the same as Case XI(b), except that Case XI(c) assumes that 50 percent of those high-school graduates entering the military take advantage of these educational benefits. Figure 4-12 shows that these three cases vary dramatically in their effects on S&E graduates, from decidedly negative for Case XI(a) to decidedly positive for Case XI(c).

V. CONCLUSIONS AND RECOMMENDATIONS

Although the specific findings to emerge from this investigation are many, they can be grouped into three main conclusions. First, reinstatement of conscription would likely have a substantially smaller effect on the future supply of scientists and engineers than might first appear to be the case from "back of the envelope" calculations. Second, the actual effects of military manpower procurement policy on the future supply of scientists and engineers depend not only on such obvious factors as force sizes and whether a draft is used, but also importantly on such seemingly second-order factors as military pay levels, quality standards, draft deferments and exemptions, and conscientious objectors. Third, the effects of change in military manpower procurement policy also depend critically on how such changes alter individual behavioral patterns, such as college participation rates. These conclusions are addressed below.

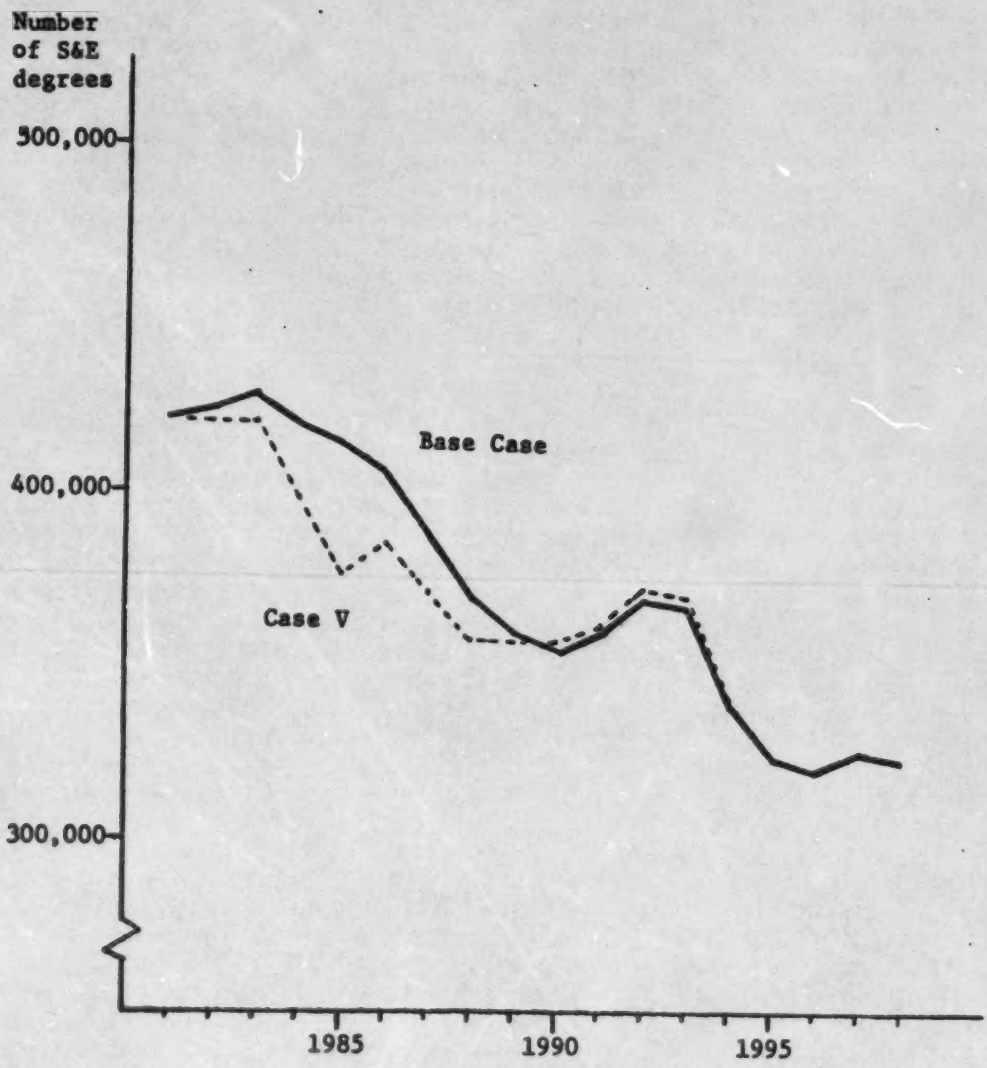
To begin, although a draft would clearly have an impact on the future supply of scientists and engineers, this impact is less than might at first be imagined. With the exception of an enormous and rapid buildup in U.S. military forces -- i.e., the "mobilization" case -- a reinstatement of the draft would result in less than a 10 percent decrease in the future supply of scientists and engineers. In fact, most of the scenarios examined would result in less than a 5 percent decrease; and some, such as using a draft to support a 2.0-million-man military, would lead to less than a 1 percent decrease. Obviously, what constitutes a severe impact depends on the problem at hand. From an enrollment viewpoint, for example, a 10 percent decrease would almost certainly be judged as severe; even a 1 or 2 percent enrollment decrease might be judged as severe from the colleges' viewpoint, since shifts of even this small magnitude could lead to the closing of some college institutions. From the viewpoint of future supply in S&E, however, the less-than-10 percent decrease in S&E degrees resulting from all but the mobilization scenario would not seem to constitute a severe problem. Only about six of every 11 male S&E graduates and only three out of every nine female S&E graduates enter S&E professions. Thus, although the imposition of a draft would certainly delay the entry of some qualified S&E graduates into the S&E professional community, there would seem to be a large enough pool of S&E graduates to draw upon such that a temporary 2-10 percent decrease in S&E graduates should not seriously affect the future supply of scientists and engineers.

There are two reasons that a reinstatement of the draft has a less adverse effect on the future supply of scientists and engineers than might first be imagined. First, the dynamics of the relationship work such that as individuals who would otherwise go to college are drawn into the military because of the draft, they are replaced by other individuals who are returning to college upon completing their military service. Second, would-be college graduates stand a smaller chance of serving than do other military-aged youth. They are less likely to serve as draft-motivated volunteers, and they are less likely to be inducted. The reason is simply that, other things equal, they have the most to gain by not serving and are thus better able to avoid military service than their non-college counterparts. Historically, this has been the case, not only when student deferments and the like were part of draft policy, but even after these draft exemptions were eliminated and the lottery introduced. Even if all draft loopholes could be closed, such that college students would stand an equal chance of being drafted, college students will still serve in smaller numbers than their non-college peers. College students are less likely to serve as true volunteers or as draft-motivated volunteers, and these two sources are likely to comprise two-thirds or more of total enlistment accessions.

The above conclusion regarding the impact of changes in military manpower procurement policy upon the future supply of scientists and engineers is subject to one important cautionary note. The foregoing indicates that -- in the aggregate -- the effects of any change in military manpower procurement policy on future S&E supply would appear to be small. Equally important is that demographic trends alone will result in a sizable decrease in the number of new S&E graduates each year through the mid-1990s. Thus, any policy change that further reduces S&E supply, as would the various draft scenarios examined here, will clearly serve to exacerbate the problem already created by the demographic trends of the 1980s. This point is illustrated in Figure 5-1, which compares the annual number of S&E graduates under the base case with those produced under Case V. As can be seen, the declining youth population during the 1980s will result in about 3 percent fewer S&E degrees in 1985 than in 1983, 17 percent fewer in 1990 than in 1983, and 24 percent fewer in 1996 than in 1983. It is clear from Figure 5-1 that the imposition of a Case V draft policy would considerably hasten the decrease in new S&E graduates. For example, under Case V there would be about 18 percent fewer S&E graduates in 1985 than there would be under the base case in 1983. To summarize, although changes in military manpower policy can be expected to have a relatively minor impact on the future supply of personnel in S&E, even these minor effects may be cause for concern, since whatever decreases in the future S&E supply brought about by such policy changes will be in addition to the already substantial decrease in S&E supply that demographic trends alone will create.

The second conclusion is that the effect of military manpower policy on the future supply of scientists and engineers depends critically on a host of factors, including military force sizes (and the resulting requirement for new recruits), military pay levels, quality standards for recruits and draftees, draft deferments and

FIGURE 5-1: Annual number of S&E degrees: Base case vs. Case V

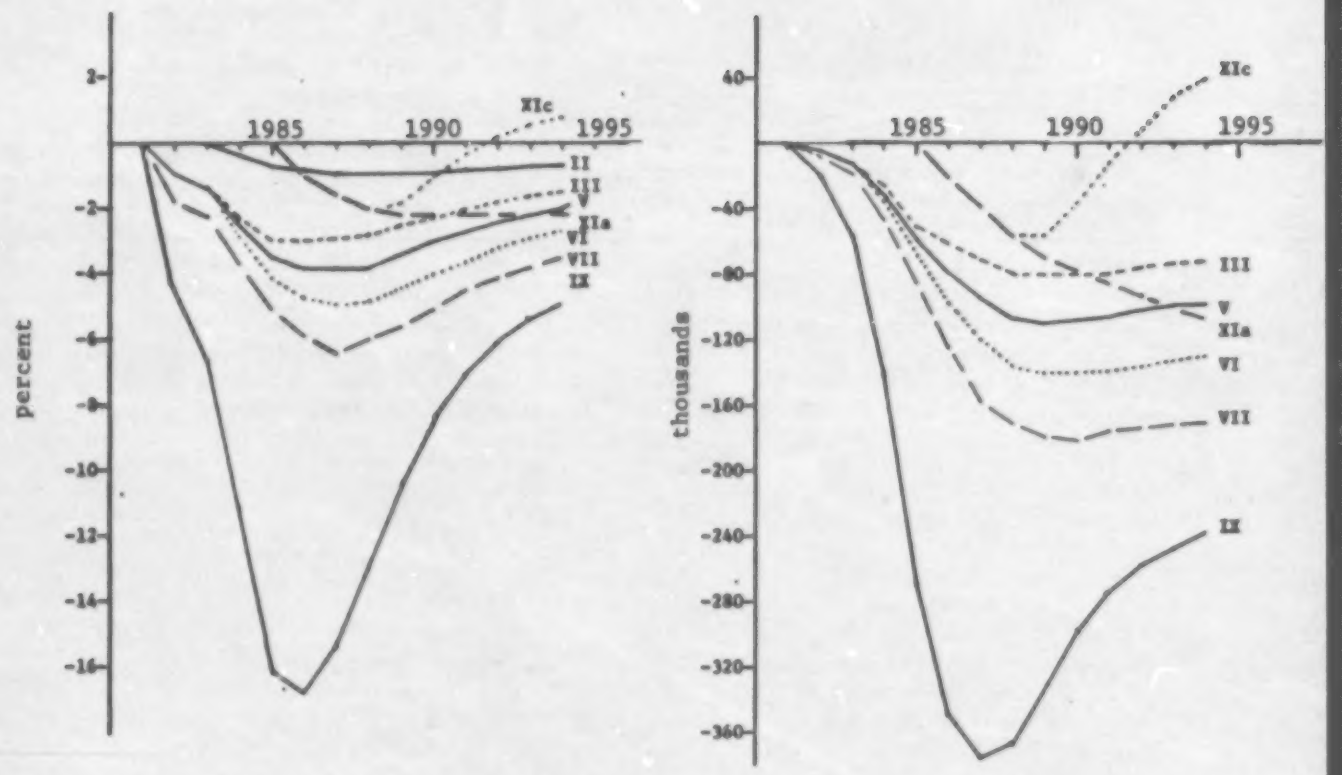


exemptions, conscientious objectors, and officer recruitment. Indeed, Figure 5-2 shows that the draft could affect from less than 1 percent of the future supply of S&E graduates to more than 15 percent under a general mobilization and rapid buildup of military forces. The results presented in Figure 5-2 show that the effects of a draft would be minimal, so long as military force sizes are maintained near their present levels. Moving to larger force sizes would obviously result in a larger impact on the future supply of S&E graduates, although the exact magnitude of these effects would vary substantially, depending on what other manpower policies would accompany such a force size increase. For example, if no other manpower policies change, then increasing force sizes to 2.5 million members (Case III) would mean less than a 3 percent decrease in S&E personnel supply. At the other extreme, if this force size increase was accompanied by such other manpower policies and effects as reduced pay and draft exemptions, larger officer force buildup, and larger numbers of conscientious objectors (Case VI*), then the draft would lead to a more than 6 percent decrease in S&E graduates -- i.e., more than twice the effect under Case III.

Third, the effects of military manpower procurement likewise depend critically on the changes on individual behavior toward college attendance and field of study wrought by changes in manpower policy. In the absence of such behavioral changes, a draft would only alter the timing of an individual's education, graduation, and entry into the job market. Thus, the results presented earlier show that the effects of a draft on S&E personnel supply gradually dissipate over time, as those returning to college keep pace with those drawn out by the draft. If, however, a draft also leads to lower college participation rates for those who serve in the military, then a reinstatement of conscription would have a permanent, negative effect on S&E supply. The converse would be true if the combination of a draft and the GI Bill would lead to an increase in college participation rates for those serving in the military.

Three areas possibly deserve further study. First, the models used to estimate the effects on the future supply of scientists and engineers could be refined. Second, other cases, or scenarios, could be considered in addition to those addressed here. And third, research could be conducted to understand better the behavioral effects engendered by changes in military manpower procurement policy. Of these, the third seems the most worthy of study at this time. It is the area where the least is presently known, and the effects of different behavioral assumptions can be substantial. In this regard, the National Longitudinal Study (NLS) of young men conducted in the late 1960s could prove to be a valuable source of information insofar as it addresses individuals' school and employment behaviors during the Vietnam era and could thus illustrate the effects of a draft on such factors as college participation rates. These research areas are focused on the specific issue of better defining the relationship between military manpower policy and the future supply of scientists and engineers. In addition to these, it would appear especially worthwhile to address the more general issue regarding the consequences of decreases in S&E supply, for whatever reasons, on the

FIGURE 5-2: Summary of cumulative S&E degrees for selected cases



nation's economic and technological well-being. Even if military manpower policy does not change, demographic trends alone will result in 20 percent fewer S&E graduates by the end of this decade, other things being equal. What do these trends mean for the nation?

TABLE A-1: Supporting data (in thousands)

	18-year-olds[a]		S&E Graduates[b]				Males Without Prior Service: True Volunteer[c]		
Year	Male	Female	Male	Female	Total	Cumulative	Total	HSG/I-III	Reduced Pay
1982	2047	1997	236	188	424	424	352	208	317
1983	1953	1911	238	189	427	851	336	198	269
1984	1861	1817	233	186	419	1270	320	189	224
1985	1812	1771	230	183	413	1683	312	184	218
1986	1788	1744	225	180	405	2088	308	182	215
1987	1816	1772	215	172	387	2475	302	178	211
1988	1861	1812	205	164	369	2844	296	175	207
1989	1855	1801	199	159	359	3203	290	171	203
1990	1713	1667	197	157	354	3557	284	168	198
1991	1634	1588	200	159	359	3916	284	168	198
1992	1619	1569	205	163	368	4284	284	168	198
1993	1642	1592	204	162	366	4650	284	168	198
1994	1634	1581	188	150	338	4988	284	168	198

a 18-year-olds as of October 1.
Source: Current Population Reports, Series P-25, No. 704, Bureau of the Census, July 1977. The Census figures are as of July 1; these were converted to October 1 according to the following formula:

$$POct_t = 0.75\ PJuly_t + 0.25\ PJuly_{t+1}$$

b Male S&E graduates for year t estimated as 11 percent of male 18-year-olds for year t-4; female S&E graduates for year t estimated as 9 percent of female 18-year-olds for year t-4.

c Estimates from Richard V. L. Cooper, Military Manpower and the All-Volunteer Force, Rand Corporation, 1977. "HSG/I-III" refers to so-called high quality volunteers.

TABLE A-2: Enlisted accession requirements: Males without prior service (in thousands)

	2.0-million-man force			2.5-million-man force		3.0- to 3.5-million-force	
	Cases			Cases		Cases	
Year	Base	I	II	III/V/VI	IV	VII/VIII	IX
1982	350	350	350	500	500	500	1000
1983	335	350	345	500	500	600	1200
1984	320	350	340	525	520	700	1000
1985	310	350	340	550	520	700	900
1986	305	350	340	525	500	700	800
1987	300	350	340	500	480	700	700
1988	295	350	340	490	460	675	675
1989	290	350	340	480	460	650	650
1990	285	350	340	475	460	650	650
1991	285	350	340	475	460	650	650
1992	285	350	340	475	460	650	650
1993	285	350	340	475	460	650	650
1994	285	350	340	475	460	650	650

NOTES

ON THE CONFERENCE

ON THE EFFECT OF MILITARY PERSONNEL REQUIREMENTS

ON THE FUTURE SUPPLY OF SCIENTISTS AND ENGINEERS

IN THE UNITED STATES

Conference on the Effect
of Military Personnel Requirements
on the Future Supply
of Scientists and Engineers in the United States

June 10, 1981
Washington, D. C.

I. Comments by the Authors

Dr. SHULL asked Dr. Wolfle and Dr. Cooper to outline the content of their papers.

Dr. WOLFLE said his paper analyzed the effect of military personnel requirements on the supply of scientists and engineers in three different cases: (1) the resumption of selective service, leading to a temporary delay, rather than a permanent abandonment, of draftees' career plans; (2) the possibility of a civilian national-service program; and (3) a McCloskey-type bill that would combine civilian service with inducements for volunteering for military service and with provisions for a draft for military service. This final possibility would require each 18-year-old to make a choice from four options: (a) 2 years of military service at a subsistence wage, (b) 6 months of active military duty followed by 5.5 years of reserve duty with the obligation to maintain combat readiness, (c) a year of civilian service at subsistence wage, (d) none of the above, with the effect that the 18-year-old would be, for the next six years, in a draft-eligible pool.

Dr. WOLFLE concluded that the above combination of national service and selective service might take 30-40% of the prospective scientists and engineers out of college for a year or two while they served. The reductions would be meaningful for institutions and for some of the individuals, but overall the number of future scientists and engineers likely to be involved, either involuntarily or voluntarily as the result of any of these programs, is not large enough to be worrisome. The change in the number of entering students would be primarily a postponement rather than an actual reduction. Also, there is sufficient time still between one's college graduation and his or her entering of the field of work that he or she could be responsive to changes in market demand, alternative wages, and other opportunities. Furthermore, the impact of the choice between those alternatives on the future flow of scientists and engineers is not critical and is not a strong basis for trying to decide between U.S. military-selection policies.

Dr. COOPER said that his paper presented the same basic conclusions as Dr. Wolfle's and was likewise aggregated. However, he tried to focus more specifically on military manpower procurement policies, presenting first a simple model of the supply of scientists and engineers and how military manpower procurement might affect it in four

categories: (1) true volunteers, people who would serve in the absence of a draft; (2) enlistees who want to avoid being inducted; (3) inductees; and (4) conscientious objectors. He then examined ways that military manpower procurement might be changed, considering several variables:

1. Size of military force needed,
2. Amount of military pay,
3. Changes in quality standards to be met by future members of the military,
4. Role and number of conscientious objectors,
5. Behavior toward deferments and exemptions, including the number of people entering the reserves, and
6. Changes in conditions for receipt of educational benefits.

He noted that three assumptions were made: (1) individual behavior would not change because of the draft; individual career goals would still be fulfilled; (2) some individuals, not otherwise planning to attend college, might attend with the availability of GI Bill assistance; and (3) some, because of being older when entering college after military service, might study more seriously.

Dr. COOPER concluded that re-establishment of the draft would not have a significant impact (estimated at .1%) on the future supply of scientists and engineers, largely because military services are able to build their forces with volunteers and there would be very little penetration into those going into college. On the other hand, changes in other variables could lead to a 6-10% impact. However, only in the event of large-scale mobilization would there be a real penetration into the scientific market; and even then, the loss of up to 17% of college graduates would be a relatively minor, temporary impact that would lessen as those who had served returned to their career plans. Ultimately, only if individual behavior is markedly changed will the number of scientists and engineers be significantly altered.

II. Discussion of the Analytic Basis of the Reports

After the two papers were presented, Dr. SHULL led a discussion of their contents. Several major issues were discussed.

Ms. VETTER asked about Table 3-1 in the Cooper paper, "Future Disposition of 18-year-olds," which is used as the basis for many later calculations in the paper. She questioned whether the proportions of scientists and engineers would remain constant over a period of time, revealing that latest figures from the National Center for Education Statistics (NCES) showed a much greater number of people earning bachelor's degrees in science and engineering. Dr. COOPER stated that if one assumes that the graph applies proportionately to each of the disciplines, perhaps exemptions -- similar to those offered in the past in shortage fields -- would be offered to those in engineering and computer sciences. Dr. MARMION stated that if full-scale mobilization occurred, deferment must be seriously considered. However, Mr. GOLDICH

noted that such channeling is not part of the present plan for the initial increment.

Ms. VETTER said she thought it was important to consider the role of women as potential scientists and engineers. In the last decade, she noted, the number of women earning degrees in science and engineering has more than doubled; the number in freshman engineering has gone from less than 1% of the class to 16% of the class in less than 10 years. NCES projections concerning the number of degrees earned by women in the physical sciences, engineering, and math show a steady increase, rising every year through 1989; for men, they start dropping very rapidly after a peak of 110,000 in 1983. Dr. MARMION felt that the military's more active recruitment of women could have a positive effect on this component of the supply of scientists and engineers. Ms. ALDERMAN noted, however, that the military has difficulty in attracting women with non-traditional skills.

Dr. MARMION noted that implementing contemplated financial aid changes, and with them a type of GI Bill, would encourage colleges and universities to take steps to enroll former military personnel, increasing the competition among colleges and universities to maintain enrollments. Educational benefits might also change the status of women and minorities who have served in the military and affect the sociological mix within science and engineering occupations.

Ms. VETTER stated that the presence of a GI Bill that provides sufficient incentive to add to the college population people who would not be there except for the military service can have a primary effect on th supply of scientists and engineers. Ms. ALDERMAN concurred, saying that some groups, generally those with higher aptitude scores, do select military service on the basis of anticipated post-service benefits.

Mr. HUCK noted that about 80% of student aid comes from the federal government. He doubted that a GI Bill would have much effect on college enrollment because, during the past decade, student aid -- instead of increasing the college population -- has led prospective enrollees to choose more expensive schools.

The topic of conscientious objectors was raised. Dr. COOPER said there have been estimates that, with a reinstituted draft, conscientious objectors might equal 40% of the vulnerable group. Dr. MARMION, however, felt that 40% was very high. Dr. COOPER concurred but felt that the status of conscientious objector was an important issue for society to decide. Mr. HUCK noted that conscientious objectors do not have a major impact if they return to their original career plans.

Dr. SHULL noted that having a conscientious-objector classification might precipitate interest in science and engineering among people who wouldn't have been interested otherwise. Ms. ALDERMAN, citing examples from the military, said that as the highly-trained skill base is enlarged, more people do transfer those skills to post-military service

occupations. Dr. MARMION referred participants to the findings of Paul Weinstein's study of occupational transfer.

Ms. VETTER noted that engineering and computer sciences are the fields with existing shortages. The very drastic changes in the number of new entrants in these fields show that there exists a need to examine the supply of and demand for engineers, computer scientists, and physical scientists as a group to determine the full impact.

Dr. MARMION cited a related concern, the cyclical fluctuations in the scientific and engineering community. Perhaps the supply of scientists and engineers could be increased if institutions were willing to assume the additional educational costs, but this action by colleges and universities will not occur as long as such fluctuations remain. He also mentioned the decline in college enrollments because of the decline in the quality of high school education and of individuals. Dr. COOPER expected the impact of this decline to be relatively minor, explaining that a 1% decline in enrollment would be substantial for colleges and universities but would have little effect on the number of scientists and engineers.

Mr. BINKIN noted that a larger proportion of the smaller cohort will be from minorities who typically have not entered the science and engineering community.

Mr. HUCK said he felt that the competition by the military for highly-skilled individuals would increase and might attract some potential scientists and engineers, decreasing the supply from the aggregate group.

Dr. SHULL noted that many countries are having similar problems in these areas: (1) young faculty problem: tenure commitments prevent institutions from hiring young people; (2) birth-rate changes in developed nations as opposed to those in underdeveloped countries; and (3) mobility of scientists within developed countries.

III. Research Agenda

Dr. SHULL directed attention to three questions: Where are there gaps in our knowledge? Where are there gaps in information flow and needs for explication of some of the issues? What else should the Commission be doing in this area? He noted that there is probably inadequate information on how an interruption in education affects an individual's choice of engineering and science. Also, the timing of this interruption might be significant.

Other participants suggested additional areas in which they felt there are gaps in knowledge:

1. How one determines the qualifications of those who are needed in the military (BINKIN),

2. What the state of the economy will be and how it will affect voluntary enlistment (ALDERMAN),

3. How occupation requirements will impact on the draft and volunteering since we do not know to what extent scientists and engineers will be required in various realms -- in the military, as DoD civilians, in defense industry -- and to what extent the scientific-educational establishment can accommodate this build-up (GOLDICH),

4. What incentive programs will be offered to individuals choosing to enter a science or engineering field (McNINCH), and

5. What effect increasing college costs will have on the availability of scientists and engineers (MARMION).

Dr. SHULL stated that an examination of areas showing shortages reveals that quantitative skills are easy to move away from, but difficult to move toward; that the quantitative skills absolutely measured in the American populace are decreasing; and that by the year 2000, there will be an absolute decline in the number of scientists and engineers in the United States because more will be retiring than entering the system. As a nation, we are becoming more technical, more oriented toward sophistication, and less able to develop the human resources needed to achieve that technology and sophistication. This must be considered by the military, the educational system, and industry.

Summarizing concerns expressed during the discussion, Dr. SHULL drew the following conclusions:

1. An important variable in the supply of scientists and engineers is the demographic decline in young people during the next decade.

2. The demand side of the equation needs further exploration.

3. No one knows at what point a draft will be instituted, with estimates ranging from two to six years, although the consensus is that the dynamics of when and how a draft happens is critical. The consensus was that the decision to institute a draft would be based on social and political grounds, not military ones.

4. The total quantitative effect of the draft upon science and engineering employment is not a large one, as concluded by both papers.

Participants added three other concerns:

1. The aggregation of scientists and engineers does not give a true picture of supply and demand in individual fields (ALDERMAN).

2. Manpower will not be sufficiently trained to operate sophisticated equipment (ALDERMAN).

3. Quality of input of future cohorts, if the present trend continues, will be lower (BINKIN).

Possible Actions by the Commission

Participants felt that the Commission should publish the two papers discussed and make them available to a wider group.

Secondly, further studies would be useful in a few areas:

1. To understand the effects of the likely kinds of perturbations that military needs might generate on the supply and demand of scientists and engineers and to develop policy alternatives for dealing with them,

2. To follow the enrollment of women in science and engineering and the extent to which the presence or absence of women in any of the discussed contexts is an important parameter (VETTER),

3. To determine the effects of a reserve draft on supply in science and engineering (GOLDICH),

4. To research alternatives to the draft, since the analytic community must influence options that are politically feasible (MARMION), and

5. To determine how student aid affects enrollment in science and engineering (BINKIN).

Appendix A

Participants in the Conference on the Effect of Military Personnel Requirements on the Future Supply of Scientists and Engineers in the United States

Harrison Shull Chairman	Chairman, Commission on Human Resources Provost, Rensselaer Polytechnic Institute
Karen Alderman	Senior Labor Economist Manpower, Reserve Affairs, and Logistics Department of Defense
Martin Binkin	Brookings Institution
George Bowden	National Institutes of Health
Richard Cooper	Economic analyst Coopers & Lybrand Washington, D.C.
Robert Goldich	Congressional Research Service
Dan Huck	Congressional Budget Office
Harry Marmion	Vice-President for Academic Affairs Fairleigh Dickinson University
Syl McNinch	Executive Assistant for Budget Policy National Science Foundation
Betty Vetter	Executive Director Scientific Manpower Commission
Dael Wolfle	Graduate School of Public Affairs University of Washington
CHR Staff	
Linda Dix	Secretary
Kathleen Drennan	Administrative Officer
William Kelly	Executive Director